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TRANSCRIPT OF RECORD

Supreme Court of the United States

OCTOBER TERM, ~~1929~~ 1930

No. ~~520~~ 19

LEKTOPHONE CORPORATION, PETITIONER,

vs.

THE ROLA COMPANY

ON WRIT OF CERTIORARI TO THE UNITED STATES CIRCUIT COURT OF APPEALS FOR THE NINTH CIRCUIT

PETITION FOR CERTIORARI FILED DECEMBER 16, 1929

CERTIORARI GRANTED JANUARY 27, 1930

(34,651)

(34,651)

SUPREME COURT OF THE UNITED STATES

OCTOBER TERM, 1929

No. 520

LEKTOPHONE CORPORATION, PETITIONER,

vs.

THE ROLA COMPANY

ON WRIT OF CERTIORARI TO THE UNITED STATES CIRCUIT COURT OF APPEALS FOR THE NINTH CIRCUIT

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[fols. a-c-e] [CLERK'S NOTE.—When deemed likely to be of an important nature, errors or doubtful matters appearing in the original certified record are printed literally in italic; and, likewise, cancelled matter appearing in the original certified record is printed and cancelled herein accordingly. When possible, an omission from the text is indicated by printing in italic the two words between which the omission seems to occur.]

[fol. 1]

IN UNITED STATES DISTRICT COURT, NORTHERN DISTRICT OF CALIFORNIA, SOUTHERN DIVISION

Equity. No. 1726

LEKTOPHONE CORPORATION, Plaintiff,

vs.

THE ROLA COMPANY, Defendant

BILL OF COMPLAINT—Filed July 13, 1926

The plaintiff, Lektophone Corporation, for its bill of complaint alleges:

1. That it is a corporation duly organized and existing under the laws of the State of Delaware, and is a resident and inhabitant of said state, having its principal office and [fol. 2] place of business in Jersey City, State of New Jersey, and on information and belief that defendant, The Rola Company, is a corporation duly organized and existing under the laws of the State of Washington, and is a resident and inhabitant of said state, and has a regular and established place of business at 45th and Hollis Streets, Emeryville, California.

2. That the jurisdiction of the court depends upon the patent laws of the United States.

3. That on the 14th day of July, 1913, Marcus C. Hopkins was the true, original and first inventor of certain new and useful improvements in "Sound Regenerating Machines," not known or used by others in this country before his invention or discovery thereof, and not patented or described

in any printed publication in this or any foreign country before his invention or discovery thereof, or more than two years prior to his hereinafter recited application for letters patent therefor, and not in public use or on sale in this country for more than two years prior to his said application, and for which no application for letters patents in any country foreign to the United States of America had been filed more than twelve months prior to the filing of the application in this country, and which had not been abandoned; that being entitled to a patent for said improvements under the provisions of the statutes of the United States then in force, the said Marcus C. Hopkins did, on the 14th day of [fol. 3] July, 1913, file in the Patent Office of the United States an application for letters patent on said invention; that said application was duly assigned to the plaintiff, Lektophone Corporation, before the issuance of said letters patent by mesne assignments duly recorded in the Patent Office; that thereafter, to wit, on the 2d day of July, 1918, all requirements of the statutes then in force having been complied with, letters patent of the United States for said invention signed, sealed and executed in due form of law were duly issued to the said Lektophone Corporation, as assignee of the entire right, title and interest therein and thereto; that the letters patent so issued were numbered 1,271,527, and said letters patent or a duly certified copy thereof is ready to be produced as this Court shall direct.

4. That on the 14th day of July, 1913, Marcus C. Hopkins, was the true, original and first inventor of certain new and useful improvements in "Acoustic Device," not known or used by others in this country before his invention or discovery thereof, and not patented or described in any printed publication in this or any foreign country before his invention or discovery thereof, or more than two years prior to his hereinafter recited application for letters patent therefor, and not in public use or on sale in this country for more than two years prior to his said application, and for which no application for letters patent in any country foreign to the United States of America had been filed more than twelve months prior to the filing of the [fol. 4] application in this country, and which had not been abandoned; that being entitled to a patent for said improvements under the provisions of the statutes of the United States then in force, the said Marcus C. Hopkins did, on the

14th day of July, 1913, file in the Patent Office of the United States an application for letters patent on said invention, which application was subsequently divided and a divisional application filed on the 17th day of April, 1918; that said divisional application was duly assigned to the plaintiff, Lektophone Corporation, before the issuance of said letters patent by mesne assignments duly recorded in the Patent Office; that thereafter, to wit, on the 2d day of July, 1918, all of the requirements of the statutes then in force having been complied with, letters patent of the United States for said invention, signed, sealed and executed in due form of law were duly issued to the said Lektophone Corporation, as assignee of the entire right, title and interest therein and thereto; that the letters patent so issued were numbered 1,271,529 and said letters patent or a duly certified copy thereof is ready to be produced as this Court shall direct.

5. That the plaintiff is still the owner of all the right, title and interest in and to the said inventions and in and to the said letters patent No. 1,271,527 and No. 1,271,529.

6. That said inventions patented as aforesaid are of great value and utility to plaintiff and to the public generally; that the plaintiff and its licensees, since the dates of said [fol. 5] inventions, have caused to be manufactured and sold acoustic devices embodying the inventions of letters patent Nos. 1,271,527 and 1,271,529, and plaintiff has expended large sums of money in causing the said inventions to be developed and has built up a large and profitable business for the exploitation of said acoustic devices, so that said inventions and patent rights have been and are of great utility and great value to the plaintiff and its licensees, and, but for the unlawful acts of the defendants herein complained of, would have been of greater value and profit to them.

7. That the acoustic devices caused to be manufactured and sold by the plaintiff and its licensees, embodying the inventions of the aforesaid letters patent are duly marked "Patented" with the date of said letters patent, all in the manner prescribed by the statutes of the United States, and plaintiff's ownership of said inventions and letters patent has been widely recognized and acquiesced in by the public and by the trade.

8. That well knowing the premises and with intent to injure and defraud the plaintiff the defendant has, since the grant of said letters patent Nos, 1,271,527 and 1,271,529, and prior to the execution of this bill of complaint, infringed upon said letters patent, and each of them, by making and selling loudspeakers embodying the invention of each and both of said letters patent, and threatens to continue so to infringe; and as an instance of the said infringement, the plaintiff alleges that the defendant has, since the [fol. 6] grant of said letters patent Nos. 1,271,527 and 1,271,529, and prior to the execution of this bill of complaint, manufactured and sold and is now manufacturing and offering for sale at its place of business in Emeryville, California, so-called "Recreator" loudspeakers embodying the invention of claims 29 and 30 of letters patent No. 1,271,527 and claims 1 to 8 inclusive of letters patent No. 1,271,529.

Wherefore plaintiff prays:

1. For an injunction, and a preliminary injunction pending this suit, prohibiting the defendant The Rola Company, its agents and employees from directly or indirectly making or causing to be made, using or causing to be used, selling or causing to be sold acoustic devices embodying the invention of either or both of said letters patent Nos. 1,271,527 and 1,271,529 and from infringing upon or violating the rights of the plaintiff in said letters patent in any way whatsoever.

2. For costs and an accounting of profits and damages, and that upon rendering a decree herein, the actual damages be trebled in view of the wilful infringement by the defendant.

3. For such other and further relief as the circumstances of the case may require.

Lektophone Corporation, by (Sgd.) Charles H. Winship, Jr., Secretary. Wm. K. White, Chas. M. Fryer, Solicitors for Plaintiff. (Sgd.) William H. Davis, of Counsel.

[fol. 7] *Duly sworn to by Charles H. Winship, Jr. Jurat omitted in printing.*

[File endorsement omitted.]

[fol. 8] IN UNITED STATES DISTRICT COURT

ANSWER TO BILL OF COMPLAINT—Filed Aug. 19, 1926

Comes now the above-named defendant, The Rola Company, and answering plaintiff's bill of complaint herein, admits, alleges and denies as follows:

I

That defendant has no knowledge or information as to whether plaintiff corporation is duly organized and/or existing under the laws of the State of Delaware and is a resident and inhabitant of said state, and therefore denies said allegation; defendant admits that the defendant company is a corporation duly organized and existing under and by virtue of the laws of the State of Washington, and has a legal and established place of business at 45th and Hollis Streets, Emeryville, California.

II

Admits that the jurisdiction of the court depends upon the Patent Laws of the United States.

III

That defendant has no knowledge or information as to allegations contained in Paragraph III of the bill of complaint herein, and placing its denial of said allegations on that ground, denies that on the 14th day of July, 1913, Marcus C. Hopkins was the true, original and first inventor of certain new and useful improvements in "Sound Regenerating Machines," not known or used by others in this country before his invention or discovery thereof, and not [fol. 9] patented or described in any printed publication in this or any foreign country before his invention or discovery thereof, or more than two years prior to his hereinafter recited application for letters patent therefor, and not in public use or on sale in this country for more than two years prior to his said application, and for which no application for letters patent in any country foreign to the United States of America had been filed more than twelve months prior to the filing of the application in this country,

and which had not been abandoned; and upon said ground denies that said Hopkins was entitled to a patent for said improvements under the provisions of the statutes of the United States then in force, or that the said Marcus C. Hopkins did, on the 14th day of July, 1913, file in the Patent Office of the United States an application for letters patent on said invention, or that said application was duly assigned to the plaintiff, Lektophone Corporation, before the issuance of said letters patent by mesne assignments duly recorded in the Patent Office; or that thereafter, to wit, on the 2d day of July, 1918, all requirements of the statutes then in force having been complied with, letters patent of the United States for said invention signed, sealed and executed in due form of law were duly issued to the said Lektophone Corporation, as assignee of the entire right, title and interest therein and thereto; or that the letters patent so issued were numbered 1,271,527.

That defendant has no knowledge or information as to the allegations contained in Paragraph IV of the bill of com- [fol. 10] plaint herein and placing its denial of said allegations on that ground, denies that on the 14th day of July, 1913, Marcus C. Hopkins was the true, original and first inventor of certain new and useful improvements in "Accoustic Device," not known or used by others in this country before his invention or discovery thereof, and not patented or described in any printed publication in this or any foreign country before his invention or discovery thereof, or more than two years prior to his hereinbefore recited application for letters patent therefor, and not in public use or on sale in this country for more than two years prior to his application, and for which no application for letters patent in any country foreign to the United States of America had been filed more than twelve months prior to the filing of the application in this country, and which had not been abandoned; and upon said ground denies that said Marcus C. Hopkins was entitled to a patent for said improvements under the provisions of the statutes of the United States then in force, or that the said Marcus C. Hopkins did, on the 14th day of July, 1913, file in the Patent Office of the United States an application for letters patent on said invention, which application was subsequently divided and a divisional application filed on the

17th day of April, 1918; or that said individual application was duly assigned to the plaintiff, Lektophone Corporation, before the issuance of said letters patent by mesne assignments duly recorded in the Patent Office; or that thereafter, [fol. 11] to wit, on the 2d day of July, 1918, all of the requirements of the statutes then in force having been complied with, letters patent of the United States for said invention, signed, sealed and executed in due form of law were duly issued to the said Lektophone Corporation, as assignee of the entire right, title and interest therein and thereto; or that the letters patent so issued were numbered 1,271,529.

V

That defendant has no knowledge or information as to allegations contained in Paragraph V of the bill of complaint herein, and placing its denial of said allegations on that ground, denies that the plaintiff is still the owner of all the right, title and interest in and to the said inventions and in and to the said letters patent No. 1,271,527 and No. 1,271,529.

VI

That defendant has no knowledge or information as to allegations contained in Paragraph VI of the bill of complaint herein, and placing its denial of said allegations on that ground, denies that the said inventions patented as aforesaid are of great value and utility to plaintiff and to the public generally; that the plaintiff and its licensees, since the date of said inventions, have caused to be manufactured and sold accoustic devices embodying the inventions of letters patent Nos. 1,271,527 and 1,271,529, and plaintiff has expended large sums of money in causing the said inventions to be developed and has built up a large and profitable [fol. 12] business for the exploitation of said accoustic devices, so that said inventions and patent rights have been and are of great utility and great value to the plaintiff and its licensees, and, but for the unlawful acts of the defendant herein complained of, would have been of great value and profit to them.

VII

That defendant has no knowledge or information as to allegations contained in Paragraph VII of the bill of com-

plaint herein, and placing its denial of said allegations on that ground, denies that the accoustic devices caused to be manufactured and sold by the plaintiff and its licensees, embodying the inventions of the aforesaid letters patent, are duly marked "Patented," with the date of said letters patent, all in the manner prescribed by the statutes of the United States, and plaintiff's ownership of said inventions and letters patent has been widely recognized and acquiesced in by the public and by the trade.

VIII

Defendant corporation denies that with intent to injure and/or defraud the plaintiff, or with any other intent or at all, the defendant has, since the granting of said claimed letters patent No. 1,271,527 and No. 1,271,529, and prior to the execution of the bill of complaint herein, or at any other time or at all, infringed upon said letters patent or said claimed letters patent, and/or each of them, by making and selling loudspeakers, embodying the alleged invention, or [fol. 13] any invention, of each and/or both of said claimed letters patent, or that the defendant corporation has otherwise, or at all, infringed upon said claimed letters patent, and/or threatens to infringe upon said claimed letters patent; and denies that the defendant corporation has, since the granting of said claimed letters patent No. 1,271,527 and No. 1,271,529, and prior to the execution of this bill of complaint, or at any other time, or at all, manufactured and/or sold and/or is now manufacturing and/or offering for sale, at its place of business in Emeryville, California, or elsewhere, or at all, so-called Recreator Loud Speakers, embodying the invention of claims No. 1 to No. 8, inclusive, and letters patent No. 1,271,527, and claims No. 1 to No. 8, inclusive, of letters patent No. 1,271,529, and denies that said defendant corporation has, in any manner, or at all, infringed upon, or threatened to infringe upon, any of said claimed letters patent, or that said defendant is engaged in manufacturing and/or selling or offering for sale, any loudspeakers of any kind or description whatsoever, embodying a part of portion of the claims No. 29 and No. 30 and No. 1 to No. 8, inclusive, of claimed letters patent No. 1,271,527 and No. 1,271,529, respectively.

Wherefore, defendant prays judgment that (1) bill of complaint herein be dismissed and that the plaintiff take nothing and that defendant be hence dismissed with its costs and disbursements herein expended; (2) and for such [fol. 14] other and further relief as to the Court may seem just and equitable.

Gavin McNab, Nat Schmulowitz, C. M. Booth, Attorneys for Defendant Corporation.

Duly sworn to by H. L. Tenny. Jurat omitted in printing.

[File endorsement omitted.]

[fol. 15] In United States District Court

Amendment to Answer Adding New Paragraphs IX, X and XI—Filed Nov. 18, 1926

Now comes the defendant above named, by its counsel, and by leave of Court first had and obtained, files the following amendment to its answer:

Page 6, after line 1, insert the following new paragraphs:

IX

And for a further and particular defense defendant is informed and believes, and so states the fact to be, that the said alleged inventions of the said patents in suit, and each of them, and each and every claim there, never possessed novelty or utility or the quality of invention, and that said patents and each of them, are invalid in all respects.

X

Defendant avers upon information and belief:

(a) That the alleged inventions set forth and sought to be claimed in said letters patent in suit, and each of them, has been patented and described in printed publications prior to the supposed invention or inventions, or discovery or discoveries thereof by the said patentee, as set out in Paragraph XI hereof.

(b) That the said Marcus C. Hopkins was not the original, or first, or any inventor or discoverer of any material or substantial part of the thing or things patented in said letters patent in suit and/or either of them.

[fol. 16] (c) That the alleged invention or inventions of the said patents in suit, and each of them, and all material and substantial parts thereof had been in public use or on sale in this country since prior to the alleged invention or inventions thereof by the said Marcus C. Hopkins and for more than two years before the filing of the respective applications for said letters patent by said Marcus C. Hopkins, and of each of them, as set out in Paragraph XI hereof.

(d) That at and before the time of the alleged invention or inventions of the Marcus C. Hopkins the said invention or inventions described and/or claimed in his said letters patent in suit, and each of them, and every material and substantial part thereof, had been patented and described in printed publications and known and used in this country, as alleged in Paragraph XI hereof; and what is described and claimed in said Marcus C. Hopkins' behalf in the aforesaid patents in suit, and each of them, did not, in view of the prior art, involve patentable invention, and that said letters patent, and each of them, are, therefore, invalid.

(e) That the said Marcus C. Hopkins surreptitiously and/or unjustly obtained said letters patent, and each of them, for that which was, in fact, originated by others, who had used or who were using reasonable diligence in adapting and perfecting the same and putting the same into use, to wit, the patentees, prior users and individuals mentioned in Paragraph XI hereof.

[fol. 17] XI

Defendant here gives notice that in support of the foregoing defenses it will introduce at the trial the following patents, printed publications and proofs of prior knowledge, invention and use, and such additional patents, printed publications and proofs of prior knowledge, invention and use as it may hereinafter discover, and when discovered it prays leave to set forth by amendment to this answer, to wit:

United States Letters Patent

Number	Date	Patentee
216,051	June 3, 1879	Maxwell
252,024	Jan. 10, 1882	Farrington
254,642	March 7, 1882	Hale
599,867	March 1, 1898	Rogers
654,360	July 24, 1900	Schopf
674,575	May 21, 1901	Duwelius
822,024	May 29, 1906	Shanks
857,209	June 18, 1907	Smith
890,142	June 9, 1908	Kraemer
963,362	July 5, 1910	Edison
986,477	Mar. 14, 1911	Lumiere
1,036,529	Aug. 20, 1912	Lumiere
1,064,062	June 10, 1913	English
1,096,676	May 12, 1914	Brown
1,180,401	Apr. 25, 1916	Johnson
1,182,078	May 9, 1916	Elfering
1,192,289	July 25, 1916	English

[fol. 18]

British Letters Patent

Number	Date	Patentee
3,393	1901	Stroh
15,060	1904	Simon, et al.
8,011	1906	Szek, et al.
8,833	Apr. 16, 1907	Hough
1,194	Jan. 18, 1908	Curteis
17,827	1909	Zappert
26,738	1909	Rosenthal
15,675	1910	Lyons
1,157	1911	Brown

French Letters Patent

Number	Date	Patentee
127,180	October 1877	Ader
331,226	1903	Gaumonte, et Cie.
362,926	1906	Welton
397,609	1908	Persichetti

German Letters Patent

Number	Date	Patentee
183,685	1906	Muller
220,412	1909	Otto

Prior knowledge and use by each and all of the patentees of the above-mentioned United States patents, at the places given as their respective addresses in said patents of said patentees.

And defendant alleges on information and belief that the said alleged inventions and said alleged improvements in said patents, and each of them, were described in other publications not now known to defendant, and were known [fol. 19] to and used by others in the United States, whose names and residences and places of use, together with such further publications, defendant prays leave to set forth by amendment to this answer, when discovered.

Chas. E. Townsend, Wm. A. Loftus, Nat Schmulowitz, Solicitors and Counsel for Defendant.

Dated November 16th, 1926.

Service of copy of the within motion for leave to amend the answer, affidavit of Chas. E. Townsend on motion for leave to amend answer, and amendment to answer adding new paragraphs IX, X and XI, admitted this 18th day of November, A. D. 1926.

Wm. K. White, Chas. M. Fryer, for Plaintiff.

[File endorsement omitted.]

In United States District Court

Amendment to Answer—Filed Dec. 2, 1927

Now comes the defendant above named, and by leave of Court first obtained amends its answer in the above-entitled cause as follows:

Under the heading "British Letters Patent" enumerated in Paragraph XI, insert the following:

Number	Date	Patentee
29,833	1910	Brown
9,418	1899	Stroh
9,712	1898	Lodge

After the list of German letters patents insert:

[fol. 20] "Publications"

"Talking Machine News," a periodical printed in London, England, dated July, 1907, Pages 243 and 244;

"Theory of Sound," published by MacMillan, 1894, New York, 2nd Edition, Pages 395 to 430;

"Dynamical Theory of Sound," published by Edward Arnold, London, 1910, Chapter V, pages 139 to 156.

Gavin McNab, Nat Schmulowitz, C. M. Booth, Chas. E. Townsend, Wm. A. Loftus, Solicitors and Counsel for Defendant.

Dated November 30, 1927.

Service of copy of the within notice of and motion for leave to amend answer and amendment to answer admitted this 30th day of November, A. D. 1927.

Wm. H. Davis, Wm. K. White, Chas. M. Fryer, for Plaintiff.

[File endorsement omitted.]

[fol. 21] In United States District Court

Opinion—Filed July 23, 1928

This suit is one of many to vindicate Hopkins' patents 1,271,527, 1,271,529.

In reports thereof, to which Lektophone Corporation vs. Brandes Corporation, 20 Fed. (2) 155, opens the door, the description and details of the discovery and invention are sufficient, save some features material to the instant case.

The patents were granted July 2, 1918, on applications, original and divisional, filed July 14, 1913, April 17, 1918. Involved herein are claims 29, 30 of the first patent, and claims 1 to 8 of the second. The defenses are invalidity and noninfringement. And the decision is that claims 29 and 30 are invalid, the others not infringed.

Claims 29 and 30 are for application of leverage to the end that the tympanum's vibrations or movements will be shorter than those of the style upon the record.

The method is as old as Archimedes, its employment in infinite variety preceded Hopkins, and his use of it was analogous, mechanical, aggregation rather than combination, and not invention.

See

Concrete Co. vs. Gomery, 269 U. S. 177.
Concrete, etc., Co. vs. Co. 23 Fed. (2) 134.

Moreover, Brown (British, 29,833), if not Lumire (986,-477), had made use of the method in the prior art. And even as here, these claims have been held invalid.
[fol. 22] See Lektophone Corp. vs. Corporation, 20 Fed. (2) 157.

Claims 1 to 8 are for the tympanum of the patents, claims 1, 2, 3, 5, 6 and 7 for a tympanum "having a free area exceeding nine inches in diameter," and claims 4 and 8, for one having "sufficient area" to realize the invention. In his specifications and during proceedings prior to patents, Hopkins committed himself to the theory that a tympanum exceeding nine inches in diameter alone would function, was necessary, and was his discovery and invention. Accordingly all claims are so taken. Likewise did he commit himself to a tympanum necessarily made of a particular kind of material and construction, tho not incorporated in any — these claims.

And because in these particulars of diameter, material and construction, defendant's tympanum or device substantially departs from plaintiff's there is no infringement.

The specifications are for improvements in sound regenerating devices, by substitution of a "tympanum of novel construction" for the sound-box and horn in common use, wherein the virtues of the former and the vices of the latter are detailed.

In description the tympanum is a hollow open cone and a surrounding flat rim at right angles to the axis, the outer edge of which rim is "tightly gripped and rigidly supported between" two metal rings.

The specifications state that "if satisfactory regeneration of sounds is to be had, the whole diameter of the tympanum" between the supporting rings "should exceed [fol. 23] nine inches in order that the conditions shall be fulfilled which are required to regenerate the sound waves"; that the diameter of the base of the cone "should exceed

in area one-half the effective area of the entire tympanum * * * or in other words * * * should be at least eight tenths'' of the diameter of the tympanum, and the height of the cone should be ''at least one quarter of the diameter of its base''; that ''it is, of course, possible to make some variation from the approximate sizes given without materially altering the result, but if the tympanum is made as shown in the drawings any great variation from these proportions will be found to effect the character of the reproduction''; that smooth surfaces and the form shown in the drawings are preferred, ''yet it is possible'' to form radial corrugations in the cone and radial or concentric corrugations in the flat rim, whereupon ''it is possible some variation from the proportions above given may be found possible and perhaps advisable, but such variations from the proportions given will not be great''; that the tympanum is of ''light vibratile material'' and ''preferably of a collodial substance'' of thickness ''according to the crispness or stiff character of the material used. Compressed fibrous material, such as hot pressed paper or fiber, has been found to act satisfactorily''; that ''it is of vital importance that the tympanum be made of crisp, strong material having considerable rigidity within itself''; that a conical shape is given the tympanum ''so that shocks or vibrations impresed upon the apex of the [fol. 24] cone in a direction toward its base will move the whole cone bodily,'' precluding wave motions therein; that the vibrations or shocks ''are to be applied to the tympanum as a whole * * * to insure the movement of the tympanum as a whole''; that otherwise, the ''paper or hard rubber'' tympanum ''would be distorted, * * * the effect of the shock upon the tympanum as a whole being entirely lost''; that the flat rim '' maintains the place of the conical active portion of the tympanum,'' permits required motion of the cone but ''resisting its displacement in just that degree necessary to maintain the form and neutral position of the active conical portion''; that considerably greater width of this rim or marked narrowing, would destroy its function ''to a degree corresponding to its departure from the approximate proportion given, and the effective portion of the conical portion of the tympanum would be proportionately lessened''; that by reason of leverage, ''the length of vibration of the tympanum

is relatively much less than that of the style," thus reducing wear of the record, and the resultant small movement of the tympanum is compensated, for that "its large area enables it to move a large body of air, so as to obtain sound waives of large volume and great carrying power."

By the file-wrappers by plaintiff presented, it appears there was prolonged controversy between the applicant and the patent office, wherein were repeated rejections of the claims for a tympanum "exceeding nine inches in diameter," because size is not patentable unless material to [fol. 25] the result. To this the applicant responded "that the size of the tympanum is what enables it to effect direction regeneration of the sound, * * * a light, vibratile tympanum of substantially nine inches in diameter or greater must be employed in order to obtain faithful reproduction"; that the size in excess of nine inches in diameter is "essential" and "has been demonstrated by the applicant by actual trial"; that the "selection of the particular dimensions is of the essence of the invention and attains novel results arising from the particular dimensions" as applicant would and did demonstrate to the examiner; that "it is essential to the success of applicant's machine that the tympanum be of large area and that the base of the vibratile portion thereof exceed nine inches in diameter"; that these are "definitions of the essential characteristics of the invention"; and that he has "demonstrated that his invention is not wholly satisfactory when the conical tympanum is made with a basal diameter of less than nine inches." Thereupon the examiner yielded and the claims were allowed accordingly.

In so far as the specifications state that it is "possible" to vary the "approximate sizes given," it is believed the reference may be to the maximum diameter of the tympanum and is to the proportions between diameter of the cone, its height, and diameter of the flat rim, their relation to each other, and not at all to lessen the diameter of the tympanum.

For the suggested possibility is followed by the warning [fol. 26] that if the tympanum of the drawings be employed, "any great variation from these proportions" (that is, size in relation one to others but not of the tympanum as a whole) will result unsatisfactorily. The same distinction

is employed in reference to variation of proportions if the tympanum be corrugated. And only such variation will be as it must be "within the scope of the claims."

See Minerals Separation vs. Co., 250 U. S. 341.

If any ambiguity in applicant's language, the construction is against him and any broadening of the claims. All this is confirmed by permissible resort to the file-wrapper of plaintiff presented.

See

Goodyear Co. vs. Davis, 102 U. S. 227.
I. T. S. Co. vs. Co., 272 U. S. 444.

To avoid rejection and to secure allowance of claims for a tympanum represented to be necessarily in excess of nine inches in minimum diameter, Hopkins represented, insisted and demonstrated the necessity, that therein was his discovery and invention, that it was of the essence and essential to success, was what enabled direct regeneration of sounds, must be employed, attains novel results, and was an essential characteristic of his invention.

Representations in these circumstances made to secure patents narrow the grants, operate as disclaimers and limitations, and as such are to be given effect. Made then, they cannot be repudiated now.

[fol. 27] See

Holland etc. Co. vs. Co. (May 14, 1928), — U. S. —;
I. T. S. Co. vs. Co., 272 U. S. 444;
Minerals Separation Case, 250 U. S. 336;
Wright vs. Yuengling, 155 U. S. 52;
White vs. Dunbar, 119 U. S. 47;
Sargent vs. Co., 114 U. S. 86;
Mahn vs. Harwood, 112 U. S. 361.

Hopkins taught that only tympanums exceeding nine inches would function, in consequence of which all the field below that figure was left open to other experimenters, discoverers, inventors. He made a particular size material.

As defendant's tympanum is only 8 7/16 inches in diameter, a size not discovered or invented and denied and disclaimed by Hopkins, a size not taught by his patents, it does not infringe. Moreover, Hopkins also made a particu-

lar kind of material and construction material to his invention, and to them the patents are limited. He described his tympanum as necessarily made throughout of crisp, vibratile material of considerable rigidity, as paper, fiber, hard rubber, to vibrate effectively throughout. The specifications stipulate that the cone shall "exceed in area one-half of the effective area of the entire tympanum," and the vibrations of the flat rim with something less than half the total area, undoubtedly materially contribute to the regeneration of sound.

In defendant's device only the cone is of crisp vibratile material, the flat rim being of limp kid, and the former alone effectively vibrates.

[fol. 28] The material of the one differs from that of the other, as do things differing in nature. Hopkins discovered and invented the one, but not the other, and his patents teach that the first is vital to success and that the second spells failure.

Difference in material results in relatively great difference in size. For whereas the diameter of the effective area" of plaintiff's tympanum exceeds nine inches, that of defendant's is but seven inches, the area of the first being 66% more than the area of the second.

To this element of material and construction is applicable the foregoing comment and citations in respect to the element of size.

In so far *is* it is urged that the flat rim is but a flexible hinge and that defendant's is an equivalent, the answer is that the patents do not so limit its function, do limit the nature of the material, and that at the time of the patents it not being known that with a flat rim if limp material the tympanum would function, the principle of equivalents does not apply.

See

Imsauser vs. Buerk, 101 U. S. 656.
Rowell vs. Lindsay, 113 U. S. 102.

True, in Lektophone Corporation vs. Brandes Corporation, 20 Fed. (2) 155, the Circuit Court of Appeals for the Third Circuit held that a flat rim of perhaps soft rubber infringes, apparently upon the principle of equivalents. But the Court took no note of the facts that the specifica-

tions declare crisp material throughout to be vital (neces-
[fol. 29] sary, that on which success depends), limit the nature of the material, attach necessity to its inherent qualities and attributes, do not limit the function, and that when the patents were granted the sufficiency of limp material was unknown.

If otherwise alike, that case and this differ in judgment, which suffices to forbid conformity merely to comply with the rule of comity urged.

Too often is the rule invoked to extend the operation of erroneous decisions and to defeat review by the Supreme Court, or for the sake of appearances and face saving. Justice is more than these latter,—is the substance whereof they are the shadows sometime distorted.

To change judgment out of mere comity, is perversion of judicial function and defeat of justice. And yet it is done whenever the facts and findings in one patent case are taken into account in another, to the prejudice of a party in the latter who is a stranger to the former.

See Carson etc. Co. vs. Co., 17 Fed. (2) 816; C. C., 26 Fed. (2) —.

For this judicial rule peculiar to patent cases tried in equity, is no justification in principle.

None of the eight claims of the second patent having been infringed, the issue of validity need not be and is not determined. It is observed, however, that at best these patents are combinations of what was old in the art, and effect little, if anything, more than difference in degree; that is, increased volume or loudness by increased capacity
[fol. 30] or area. They are somewhat analogous to a patent for a 50-gallon barrel by the inventor discovered possible in a world of 5-gallon kegs, hardly invention, even when the first time made (always is a first time, however obvious and mechanical), and though extensively used.

Hopkins tympanum differs nothing from Brown's (British, 29,833), Stroh's (British, 3,393), and Dann and Lapp's (338,660), and little from English's (1,192,289), save in point of size and consequent volume; and Brown had taught, if the obvious needs teaching, that increase in size would increase volume or loudness.

This had actually been done by Starling and Carr (Talking Machine News, July, 1907), and plaintiff's tympanum

is theirs supplied with the rim and support of the others. Lumire too (1,036,529), whose device is many quassi cones, expressly taught increased size, torsion, avoidance of nodes, and vibration as a whole by shock to the apex of the cone.

It would seem that the original thought or purpose of a crowded art to reproduce sounds more or less loudly, was carried forward by Hopkins in the same way by substantially the same means, though by increased size to corresponding increased results.

That some of the analogous devices of the prior art were transmitters and not receivers is immaterial, for any learned in the art knew that with some adjustment, either would serve for the other. Such change is not invention.

See Western Co. vs. Larne, 139, U. S. 605.

[fol. 31] Decree for defendant.

July 17, 1928.

Bourquin, J.

[File endorsement omitted.]

In United States District Court

Equity. No. 1726

Lektophone Corporation, Plaintiff,

vs.

The Rola Company, Defendant

Final Decree Dismissing Bill—Filed July 30, 1928

This cause having come on to be heard before the Court on the 10th and 11th days of May, 1928, and having been brought to a final hearing, upon the pleadings and proofs, and counsel for the respective parties having been heard, and the cause having been fully considered by the Court and an opinion having been filed therein on the 23d day of July, 1928, it is hereby

Ordered, adjudged, and decreed that the bill of complaint herein be and the same is hereby dismissed, and that de-

fendant be allowed its costs and disbursements to be taxed by the Clerk in the sum of $131.44.

[fol. 32] The Court's decision is referred to.

Bourquin, United States District Judge.

Dated July 27, 1928.

Approved as to form as provided by Rule 22.

Wm. H. Davis, F., Attorney for Plaintiff.

[File endorsement omitted.]

IN UNITED STATES DISTRICT COURT

DOCKET ENTRIES

July 13th, 1926.—Filed complaint. Issued subpœna ad res. Made cert. to Com. of Patents.

July 14th, 1926.—Filed Subpœna ad res. with return showing service on The Rola Company on July 14.

August 19, 1926.—Filed answer.

Sept. 14th, 1926.—Filed stip. ex. time to file interrogatories. Filed stip. extending time. Filed stip. ex. time. (Interrogatories.)

Sept. 28th, 1926.—Filed stip. ex. time to file interrogatories.

Oct. 30th, 1926.—Filed order ex. time to file interrogatories.

Nov. 18th, 1926.—Affidavit and amd't to answer.

Dec. 7th, 1926.—Filed notice of hearing motion. Ord. motion for leave to amend answer granted, etc.

[fol. 33] Dec. 13th, 1926. ——.

Mar. 7th, 1927.—Ord. trial set for June 7.

May 14th, 1927.—Filed stip. con. to July Term.

Aug. 2d, 1927.—Ord. con. to Sept. 6 to be set. Filed stip. to drop from calendar.

Sept. 19th, 1927.—Ord. con. to November Term.

Nov. 14th, 1927.—Ord. trial set for Dec. 20. Filed stip. Ord. trial con. to Jan. 3, 1928.

Dec. 2d, 1927.—Filed notice of and motion for leave to amend answer. Filed stip. ord. trial con. to Feb. 7, 1928.

Dec. 12th, 1927.—Ord. motion for leave to amend answer granted.

Jan. 19th, 1928.—Filed stip. regarding identification of patents. Filed stip. regarding use of testimony.

Feb. 15th, 1928.—Ord. trial con. to March 20.

Mar. 3d, 1928.—Filed stip. ord. trial con. to April 24.

April 2d, 1928.—Order trial con. to May 10.

May 10th, 1928.—Ord. trial evidence intro. and trial con. to 11th.

May 11th, 1928.—Ord. trial resumed. Evidence intro. and cause submitted. Filed reporter's transcript.

May 31st, 1928.—Filed reporter's transcript.

June 23rd, 1928.—Filed deft.'s memo.

July 17th, 1928.—Filed pltf.'s memo.

[fol. 34] July 23rd, 1928.—Filed decision. Ord. decree entered in favor of deft. Made and mailed copy of order to attys.

July 30th, 1928.—Filed decree and entered same. Made and filed enrolled papers.

Aug. 1st, 1928.—Filed memo. of costs.

Sept. 12, 1928.—Filed petition for order allowing appeal.

Sept. 12, 1928.—Filed assignment or errors. Filed and entered order, allowing appeal. Filed bond. Filed citation.

Dec. 26th, 1928.—Filed condensed trial record. Filed joint præcipe and stipulation.

In United States District Court

Statement of Evidence

After an opening address by Mr. Davis for plaintiff, the following plaintiff's exhibits were received in evidence:

Plaintiff's Exhibit 1—Printed copy of patent to Marcus C. Hopkins, No. 1,271,529, July 2, 1918.

Plaintiff's Exhibit 2—Printed copy of patent to Marcus C. Hopkins, No. 1,271,527, July 2, 1918.

[fol. 35] Testimony on Behalf of Plaintiff

Testimoney of Louis A. Hazeltine for Plaintiff

Louis A. Hazeltine was called as a witness on behalf of plaintiff, was duly sworn, and testified as follows:

Direct examination.

By Mr. Davis:

I am forty-one years of age and am a research engineer. I graduated from Stevens Institute of Technology in the year 1906, with the degree of mechanical engineer. A year later I joined the Electrical Engineering Department at Stevens, with which I was connected until 1925, being for eight years the head of the department, with the title of Professor of Electrical Engineering. During that time I, of course, studied problems connected with telephony, which includes acoustical phenomena. I took up, as a specialty, the subject of radio, which depends for its final usefulness on acoustic phenomena, particularly as connected with loudspeakers. During the last two or three years I have made a special study of loudspeaker operation, of a mathematical and also of an experimental nature, having had several models built under my design.

I have made a study of the patents here in suit. I believe that the description occurring in lines 27 to 66 of page 1, of patent No. 1,271,529, as to the mode of operation of the sound-box and horn combination is quite correct as far as [fol. 36] it goes. In carrying that discussion a little further to explain how the sound-box and horn combination impresses on the air sound waves of different pitch or frequency of vibration within the audible range—there are two problems that arise and call for the use of this combination or other means. The first of these problems arises from the fact that air is an exceedingly soft or yielding medium, so that when you attempt to set air into vibration by moving a relatively heavy solid object, you find that that air does not offer sufficient resistance, naturally, to enable it to absorb power readily. To an electrical engineer, the analogy is the operation of an electrical generator very nearly on short circuit, so that although there will be lots of current produced there will be very little pressure built up, and relatively a small amount of power, assuming that the generator current is limited by its internal reaction. The fact that that air is so soft or yielding requires the use of a sound-box with a relatively small opening, so that the air, in issuing from that opening, will act more stiffly on the

diaphragm which is inside of the sound-box. The effect is essentially the effect of a leverage. The pressure which is applied in the throat or opening exists there over a small area. The diaphragm, ordinarily has a larger area, several times larger, so that the pressure, reacting on the diaphragm, is greater by reason of its greater area (that is, the total force or integrated pressure), and that is more suited to the mechanical characteristics of a solid body such [fol. 37] as a diaphragm. The use, therefore, of the sound-box with this relatively small opening solves one of the two difficulties which I have in mind, that is, it gives a stiffer effect, a stiffer reaction against the diaphragm. However, another difficulty appears, which is even more serious, as it ordinarily arises, and that is that when sound waves of mechanical air vibrations are initiated at the surface of a relatively small opening, or, in general, over any relatively small surface, they will set the air in the immediate neighborhood into vibration, and there will be comparatively little radiation of sound. That is one of the peculiarities of wave motion that is somewhat hard to visualize although it is comparatively easy to work out in a mathematical way and has been recognized since the earliest study of the wave motion. It can be likened to wave motions set up in water, which are the wave motions that are perhaps easiest to visualize. If we take water and move a very small object in it, for instance, if one puts his finger into water and moves it back and forth, there will be a certain carrying along of the water with the finger that makes the finger feel as if it were heavier than its own natural weight; but the vibrations produced in that way do not produce any considerable amount of wave motion. The vibrations produced in that way are largely confined to the water in the immediate neighborhood of the finger. On the other hand, if you take a board or paddle, and move that back and forth in [fol. 38] the water at the same rate as before, distinct wave motions will be produced, and waves will radiate out from that paddle to a considerable distance. The reason is that that the dimensions of that paddle are of the same order of magnitude as the wave length, the distance between crests of the waves that are produced; whereas when the finger was moved at that rather slow rate the dimensions of the finger are very small compared with the length of the waves

(and that is the criterion, as far as vibration will result in waves of water), so it will be largely a local phenomenon. Now, in air, the length of the wave of sound is directly calculated from the pitch or frequency, and from the velocity of sound. The frequencies that are most useful in speech and in music, the frequencies that we care the most about, are from about 100 cycles per second up to about 5,000 cycles per second. Actually, we can hear down to something of the order of 30 cycles per second, and up to 10,000 to 20,000 cycles per minute, the upper limit varying considerably with the individual. The velocity of sound in the air is about 1100 feet per second, and if we divide that velocity by the frequency we get the wave length; so that at a frequency of 1100 cycles per second, which is right in the middle of the useful range, we will have a wave length of one foot. At low frequencies we get wave lengths of several feet; at 100 cycles per second the wave length would be 11 feet; if we adopt a criterion such as I have just mentioned, in order to get real effective wave action, we should have an aperture of the order of 11 feet. That, however, is [fol. 39] a little too rough to be precise. More accurately, we can say, that radiation is good if the diameter of the radiating surface is about one-third of a wave length, so that we would need to have a vibrating surface of the order of four feet to very effectually reproduce a frequency of 100 cycles per second. Now, the diameter of the aperture of the sound-box would evidently be a fraction of an inch; that is so entirely out of the order of magnitude required for effective radiation, until we get the very high frequencies, that it is quite unsuited for a sound reproducer. That difficulty is gotten around partially, and, in some cases, quite successfully, by fitting to the end of the aperture the ordinary horn. If a horn is made with a diameter at its mouth of the order of four feet, if it is made long enough so that its rate of expansion is not too great, so that as the wave passes through its narrow throat to its wide mouth, it expands very gradually, then the reproduction can be quite satisfactory. But, of course, a horn with a diameter at its mouth of four feet is objectionable for a great many uses. The ordinary horn with a diameter of less than a foot at its mouth will not satisfactorily reproduce the low frequencies. Of course there can always be some repro-

duction, because any kind of vibration will result in some sound, but in order to get a considerable amount of sound at a low frequency with the ordinary small horn, the amplitude of vibration, that is, the distance which the center of the diaphragm must traverse, becomes quite prohibitive, [fol. 40] and that is the reason why the character of speech or music is lost to a considerable degree in a sound reproducer employing a sound-box and horn.

As to how a direct acting sound generating device of the kind specifically described and illustrated in Hopkins patent 1,271,529 (that is, one having a tympanum supported in a rigid frame, and comprising a central conical portion made of paper from three to twenty thousandths of an inch thick, with a base not less than 7.2 inches in diameter, and an altitude of at least 1.8 inches, and a supporting rim extending from the edge of the cone to the rigid frame) reproduces sound—in the first place, the conical portion is large enough so that it acts on a relatively large area of air and on that large area of air is an integrated pressure or force which reacts against the driving mechanism sufficiently to give efficient radiation of power.

In the second place, that form of diaphragm, the conical form, is of great stiffness, structurally, so that although the paper is thin and thereby has very desirable lightness, yet it is stiff relatively to any pressure which is applied at its apex. For example, I have such a cone here. It is a simple cone with no rim of any kind. When I lay the base of the cone flat on the table and press on the apex I can press with a force which is certainly over a pound, and the deflection at that apex is noticeable only when you examine it carefully. It acts quite stiffly and rigidly. When a vibration of relatively low frequency is applied by a motor to the [fol. 41] apex of that, the cone will move bodily and will displace the air all over its surface. The contrast with a sounding box and horn may be made in this way: Assume that we have a cone with a diameter of eight inches, which is a usual diameter, and assume that with a sound-box we have a diaphragm whose effective diameter (that is, the diameter of an equivalent piston) is one inch, which is also a reasonable diameter, then the area of the cone (by which I mean projected area, that is, the area of the base) would be 64 times (the square of eight) the effective area

of the diaphragm which is to be within the sound-box. In order at very low frequency to have the same amount of sound produced, we would have to have 64 times the linear motion of the diaphragm in the sound-box, to what is needed in the case of the cone. The cone might, for example, have a total excursion at its apex of say four thousandths of an inch. In order to get the same radiation of sound at low frequency from the sound-box and horn we would have to have a diaphragm moving about one-quarter of an inch. Now, a motion of a quarter of an inch of a driving mechanism of that sort is out of all reason. It means that such low frequencies cannot be reproduced effectually with the ordinary sound-box and small horn. The conical diaphragm having the dimensions which you mentioned, therefore, has the practical result of enabling sound radiation to be produced over the useful frequency range, which is not the case with the ordinary horn type.

[fol. 42] Q. Now, in the construction as you have described it——

The Court: I do not think there is any particular issue or dispute as to the difference between this device and the old sound-box, is there?

Mr. Davis: I think there will be, your Honor.

The Court: Is there, Counsel?

Mr. Loftus: I do not think that is in issue, at all, your Honor.

The Court: Proceed, briefly.

(Witness proceeds.)

This cone, as I have just described it, is very stiff relative to a force applied to its apex, but is relatively very yielding with respect to a force applied around its periphery, because this cone which I have is quite unsupported at its periphery. The result, which experience showed, and which was a very serious one, was that when such a cone was set in vibration by having connected to it a motor through its apex, although it had a tendency to vibrate as a whole, yet it was so easy for it to vibrate in a way which might be described as fluttering, but is more often spoken of as weaving—that such a weaving motion would be found to be set up. That motion is one in which different portions of the

cone moved in opposite directions around the periphery, that is, the top might be moved forward and the bottom moved forward, and the two sides moved backward, all at the same time, setting up what are known as radial nodes. That is, in the case I have just described there would be [fol. 43] four lines equally spaced on the conical surface that would be stationary, or nearly so, and the four segments between those lines would be vibrating in opposite directions.

The primary function of the supporting rim extending from the edge of the cone to the rigid frame is to cure the weaving motion which I have just described. That weaving action results, practically, in a disagreeable blasting noise, prominent particularly at some of the low frequencies, that make the whole device very unpleasant to operate. A comparatively small constraint around the periphery will prevent the weaving action to any objectionable degree. On the other hand, if that constraint at the periphery is too great, if, for example, the periphery is fastened rigidly, then the whole diaphragm can only yield by bending, and it becomes much too stiff to suit the driving motor, and properly radiated sound, so that the thing which makes this a useful operative structure in that respect is a rim which is flexible, and which allows just a proper amount of yielding, so that the cone moves bodily, with little restraint, and the weaving action which results in blasting is, to all practical purposes, eliminated.

Mr. Davis: May I for a moment call the Court's attention to a statement in patent 1,271,527, beginning at line 124, on page 3, where the patent says:

"The plane peripheral portion 1 of the tympanum main- [fol. 44] tains the place of the conical active portion of the tympanum and yields sufficiently to permit of the required motion of the conical portion, resisting, however, displacement of the conical portion in just that degree necessary to maintain the form and neutral position of the active conical portion."

Plaintiff's Exhibit 3.—The Rola Loudspeaker complained of as an infringement, is received in evidence as Plaintiff's Exhibit, 3, it being stipulated that this loudspeaker was sold by the defendant company after the issuance of the

patent in suit, within six years prior to the filing of the bill of complaint herein.

Comparing defendant's loudspeaker, Exhibit 3, with the structure of patent 1,271,529, I find in it an embodiment of the patent disclosure. I find that this exhibit has a tympanum or diaphragm with a central conical portion, having a diameter which I measured and found to be 7 9/16 inches, which is greater than the lower limit indicated in the patent of 7.2 inches. This conical portion is made of paper, and as described in the patent.

I have measured the thickness of a cone which appears to be identical with this, and have found the thickness of the paper to be between 8 and 9 thousandths of an inch which is between the limits stated in the patent, of 3 to 20 thousandths of an inch.

I have measured the height of the cone, the distance from the apex to the plane of the base, and found that it be two inches, which comes within the limit stated in the patent [fol. 45] for the relation of the diameter.

Outside of the active conical portion, I find a flexible rim, which is here apparently of leather, and that rim is more flexible in its material than is paper, and is correspondingly narrower than it would be if made of paper, as indicated in the patent.

The rim is fastened, in turn, at its outer edge, to a solid rigid metal support.

Plaintiff's Exhibit 4.—Two drawings of defendant's loudspeaker (Exhibit 3) are received in evidence as Plaintiff's Exhibit 4.

I believe the mode of operation of defendant's loudspeaker is just the same as the mode of operation described in the Hopkins patent.

The motor element is connected with the apex of the cone, which is set into vibration, which acts directly on the unconfined air to initiate sound waves, which are then radiated.

Around the active conical portion is the rim to which I have referred. That has the effect of eliminating the blasting which I have described, and also of holding the conical portion in a neutral position, so that it will not get out of line, just as I have described, in the Hopkins patent, and it

has sufficient flexibility to offer an effective restraint to the normal motion of the diaphragm.

With reference to the subject matter of the other patent No. 1,271,527, I have examined the actuating movement of defendant's loudspeaker and find that it embodies a lever [fol. 46] reduction such that the vibrations imparted to the tympanum are relatively much shorter than the vibrations imparted to the actuating armature. The tympanum is fastened at its center to a rod which, in turn, is soldered on to a lever. That lever has a fulcrum at one end, and has rod going to the tympanum at the middle, and a rod going to the armature at the other end. I have measured the lever arms, and found that the lever arm from the tympanum rod to the fulcrum is three-eighths of an inch, and from the rod going to the armature the lever arm is nine-sixteenths of an inch, so that the cone or tympanum moves through a distance two-thirds of that moved through by the end of the armature to which the rod is attached.

Plaintiff's Exhibit 5.—A drawing of the actuating device of defendant's loudspeaker (Exhibit 3) is received in evidence as Plaintiff's Exhibit 5.

Cross-examination.

By Mr. Loftus:

Q. You stated that the operation of the Rola cone was the same as that described in the Hopkins patent. What is the nature of the peripheral rim, as described in that Hopkins patent, what material is that formed of?

A. The rim is a plain rim, which is said to be flexible. The material is said to be of a colloidal substance, and it is also stated that "Compressed fibrous material, such as hot-pressed paper or fiber, has been found to act satisfactorily." It seems to leave it open.

[fol. 47] Q. It is also stated there that the material be "crisp, strong material, having considerable rigidity within itself," is it not—page 2, line 104 of the patent 1,271,529?

The Court: If it does, you have read it; tell him so and base the question on it.

Q. What would be the purpose of forming the rim of the cone of this crisp, strong material?

A. The cone is supposed to have considerable rigidity—

Q. Likewise the rim, isn't that true?

A. It must have enough rigidity to bring the cone back into a neutral position and prevent the weaving action, which results in blasting.

Q. In other words, that rim, then, was intended to be made of springy material. Is that correct?

A. All materials are springy to some degree. It must have enough springiness to achieve the results which I have just stated.

Q. Do you find any springiness in the leather rim of the defendant's device?

A. In the sense that I have indicated, I do. I find, if the leather is pushed to one side, displaced, it would tend to return to its normal position, and that is the characteristic of springiness.

Q. But, ordinarily, kid leather is not considered a springy material?

A. That depends upon how it is mounted. If it is mounted so that it can be under tension when it is deformed it may have appreciable spring action.

[fol. 48] Q. In the defendant's device which you have just referred to, and which has been offered in evidence, what constitutes the tympanum?

A. The active conical portion, which is the paper, and the rim, which is apparently of leather.

Q. What is your definition of a tympanum?

A. I have given my understanding of tympanum, based on the description of the patent.

Q. What is your understanding, ordinarily, of a tympanum?

A. I have never used the word, myself.

Q. You are not familiar with the word at all?

A. I have heard the word, but I have not seen it often enough, nor have I looked it up in the dictionary, to know what the definition really is.

Q. In the Hopkins patent, this flat rim is part of the sounding-board, that is, it gives off some of the sound, does it not?

A. It gives off some sound, but my understanding of the patent is that the active sound-producer, that is, the part which gives out the major portion of the sound, is the cone.

Q. But the flat rim does the same to a certain extent?

A. To a certain extent, and incidentally.

Q. But in the defendant's device that limp leather is not any part of the sounding-board, is it?

A. It is not an important part. There must be some vibration, therefore some sound produced by it.

Q. Not audible, though?

[fol. 49] A. That is a matter of degree. It is not important, I said.

Q. Now, what is the diameter of the tympanum in the defendant's device which you have referred to?

A. 8 7/16 inches, I measured.

Q. And what was the least diameter which you found specified in the Hopkins patent?

A. 9 inches.

Q. Now, you notice, of course, that the defendant's device is equipped with a surrounding frame or baffle-board. What is the purpose of that?

A. I believe that the most important purpose is to separate the motion of the front surface of the diaphragm, as it acts on the air, and the motion of the back surface, so that at low frequencies those two effects, one compressing the air, and the other rarifying it, will have less tendency to counteract one another.

Q. Without that baffle-board it would be impossible to get those notes of lower frequencies, would it not?

A. That, again, is entirely a matter of degree.

Q. I am speaking now of a cone of the size of the defendant's cone, that is, one under nine inches.

A. The baffle-board in the defendant's device is relatively a small one. It is not large enough to be completely effective, yet it is large enough to do an appreciable amount of good, I believe.

Q. Without the baffle-board, the defendant's cone would not be a commercial article, would it, or an effective sound reproducer?

[fol. 50] A. I think it would be a commercial article. I think, while not the best, it would be certainly very much better than any, if not most, horn-type speakers.

Q. But with the baffle and that small cone, you are able to produce those notes of low frequency which you otherwise would not obtain, isn't that a fact?

A. It is a matter of degree, but, generally speaking, that is true. You always get some low notes. You get more with the baffle than you would without.

Q. Do you find anything in the Hopkins patent with respect to the use of the baffle?

A. I do not find that the baffle is mentioned as such, although it is possible that the enclosing of or partial enclosing of the tympanum might have some such effect, to a certain degree.

Q. But there is no partial enclosing of the tympanum, is there?

A. I find that in some of the drawings the walls are shown rather close to the edge of the outer rim, and although I do not think that that is an important effect, I do not feel justified in entirely disregarding it.

Q. What would you say was the size of the tympanum illustrated in the Hopkins patent, comparing it with the diameter of the turntable?

A. It is slightly less in outside diameter than the turntable.

[fol. 51] Q. That turntable ordinarily is of what diameter?

A. I really do not know. I do not think that that is a fixed thing.

Q. You know what size phonograph records come in, do you not? You have seen sixteen-inch records?

A. Yes, I have seen them. I do not use the phonograph, myself, but I have seen them, of course, and handled them a good many times.

Q. Some of them as much as sixteen inches in diameter?

A. I have never handled one as large as that.

Q. Now, with a large cone, such as the Hopkins patent discloses, it really is not important to provide any baffle, is it?

A. That, again, is a question of degree. Without the baffle it is my opinion that it would still be materially better than the horn-type speaker, of the ordinary form, I believe that it may be somewhat improved by the use of a baffle, or by making it not at the lower limit indicated by the Hopkins patent, but at some point greater than that lower limit.

Q. But you will agree that where a cone of the large size specified by the Hopkins patent is employed, the importance of providing a surrounding baffle is not nearly so vital as in the case of the small Rola cone that defendant manufactures. That is true, is it not?

A. I cannot agree with the implication of the question. [fol. 52] The size of the Rola cone is within the limits of the Hopkins patent.

Q. Well, you just said that it was less than nine inches.

A. I did not say that the cone was less than nine inches. Your question had to do with the total tympanum, which is just a little bit less in the Rola device than is specified in the lower limit of the Hopkins patent, but the cone which you ask about in your other question is a little larger than he specified.

Q. See if you cannot answer that question now.

A. The question seems to have a misstatement in it, so that I cannot answer it.

Q. I thought that we agreed the Hopkins patent disclosed a cone somewhat in excess of nine inches, and that the defendant's cone was less than nine inches.

A. The defendant's cone is less than nine inches, and the Hopkins cone can have any size greater than 7.2 inches.

Q. Where do you find that 7.2 inches specified?

A. It is specified that the base of the cone should be greater than eight-tenths of the diameter of the tympanum, and the diameter of the tympanum should be greater than nine inches, and eight-tenths of nine inches is 7.2 inches.

Q. But my question is directed to the over-all diameter between the rings. You concede that the defendant's device is much smaller between the rings than that disclosed in the Hopkins patent.

[fol. 53] A. No, it is a little smaller, it is only a fraction of an inch smaller than the lower limit of the Hopkins patent.

Q. When you get diameters of less than nine inches between the rings, then it is true that it becomes of greater importance to provide the device with a baffle than where you are dealing with larger diameters, such as the Hopkins drawings apparently show?

A. I am not convinced that the Hopkins drawings do apparently show that, but without that limitation it is correct in general that the smaller the diameter of the tympanum the more important it becomes to use a baffle.

Q. And without that baffle, you lose those lower frequency notes, do you not?

A. You do not lose them, but you have them weakened.

Q. They do not seem to be there, to the ear?

A. That, again, is a question of degree; if you are close up you can hear them quite plainly, if they exist, but if you are farther away you won't hear them so well.

Mr. Loftus: That is all.

Redirect examination.

By Mr. Davis:

The effect of changing the width and stiffness of the rim that supports the cone in one of these devices is that if the rim is made narrower, it should be correspondingly of more flexible material, so that the final stiffness effect will be of [fol. 54] the order of magnitude to get the result called for in the patent. In defendant's cone, the rim is narrower, but it may be of more flexible material.

Plaintiff's Exhibit 6.—A certified copy of the file-wrapper history of patent 1,271,529 is received in evidence as Plaintiff's Exhibit 6.

Plaintiff's Exhibit 7.—A certified copy of the file-wrapper history of patent 1,271,527 is received in evidence as Plaintiff's Exhibit 7.

Plaintiff's Exhibit 8.—A binder containing certain patents cited by the Examiner during the prosecution of the applications is received in evidence as Plaintiff's Exhibit 8.

STIPULATION RE PATENTS

(It was stipulated between counsel that the patents to Holden, No. 762,904, Head, No. 805,544, Walker, No. 805,600, and Hogan, No. 632,015, are the patents referred to in the following statement contained in the amendment of March 28, 1916, filed during the prosecution of the application which resulted in Hopkins patent No. 1,271,527, the statement being as follows:

"In respect of the prior art patents, not of record, but to which attention has been called, and which shows horns or other amplifying devices made of paper or the like, and directly associated with the needle or stylus.")

Close of prima facie case.

After an opening address by Mr. Loftus for defendant, the following defendant's exhibit was received in evidence: [fol. 55] Defendant's Exhibit 9.—A binder of prior art patents and publications is received in evidence as Defendant's Exhibit 9.

Testimony on Behalf of Defendant

(Mr. Loftus referred to a stipulation between counsel by which certain depositions were agreed to be admitted, the depositions being those Edward K. MacEwan, Albert C. Diehl, and Mr. Harry O. Sooy, in the case of Lektophone Corporation vs. Western Electric Company, United States District Court for the Southern District of New York, and then after having obtained permission of the Court proceeded to read the depositions.

The above-mentioned stipulation is as follows:)

Stipulation re Depositions

"It is hereby stipulated that the three depositions attached hereto, being the testimony of the persons named in a cause entitled Lektophone Corporation vs. Western Electric Company, Incorporated, in Equity No. 30—234 in the United States District Court for the Southern District of New York, and the exhibits, identified by the said persons and introduced and used in the said cause No. 30—234 as Exhibits 'A' and 'B,' may be used by the defendant in this above-entitled cause, with the same force and effect as if said depositions and exhibits were regularly taken, and introduced in this cause. It is further stipulated that the total manufacture of loudspeakers using the diaphragm of [fol. 56] Exhibit 'A' by the Victor Talking Machine Company did not exceed 40,000, and that none have been manufactured or sold except in the years 1925 and 1926."

Deposition of Edward K. MacEwan for Defendant

(The deposition of Edward K. MacEwan, included by the above-mentioned stipulation, reduced to narrative form, is as follows:)

Direct examination.

By Mr. Scull:

My residence is 6334 Woodbine Avenue, Overbrook, Pennsylvania. I am secretary of the Victor Talking Machine Company, whose plant is located at Camden, New Jersey. I have been employed by the Victor Talking Company since 1900. In 1908 or 1910 I was assistant to Mr. English, who had charge of the experimental laboratory and my duties principally at that time were the manufacturing of the recording material and assisting Mr. English in clerical matters.

(The witness was shown a device and asked if he knew what it was.)

Yes, that is a machine that came over to the laboratory—to the best of my knowledge, that is the same machine that came over to the laboratory of the Victor Talking Company in either the latter part of 1908 or 1909, the early part of 1909. It is a Lumiere machine. I heard it played in 1909. I considered that it had very much broader tone of production that machines we were making at that time. At that [fol. 57] time we were making an enclosed horn and sound-box machines.

Subsequent to my hearing this machine in 1909 the Victor Company experimented with diaphragms of the Lumiere type. The purpose of the experimenting was to try to accommodate the Lumiere diaphragm to the product that we were making at that time.

As to the location of the diaphragm in these experimental machines with relation to the support for the record—as I recall in the early experiments, the diaphragm rested on the turntable, but their object was to try to make it more accessible for use, more convenient, and they later on developed a machine in which the diaphragm was placed in an upright position. When I say convenient I mean to get it away from the turntable.

The Victor Company are making loudspeakers to-day with these plaited paper diaphragms and those loudspeakers are for radio purposes. The diaphragm is substantially the same as the one on the machine which I have identified.

(The machine identified by the witness was received in evidence as Defendant's Exhibit "A.")

NOTE.—A Photographic reproduction of this Defendant's Exhibit "A" is in evidence as Defendant's Exhibit 34 in this case.

In making these radio loudspeakers with the plaited diaphragm the Victor Company was doing so under a license under the Lumiere patents. As to when the Victor Com- [fol. 58] pany entered into a license arrangement with Lumiere,—they took an option according to my recollection in the early part of 1909. That option was taken up and they have a contract.

In the experiments of which I have any knowledge, no change that I know of was made in the diaphragm itself of Exhibit "A." The experiments which I have mentioned were merely to fit these large diaphragms into the Victor cabinet machines. Also they had it so arranged that they could use it on a table type machine.

As Secretary of the Victor Company I am fairly familiar with the sales of Victor talking machines. Something over three hundred thousand Victor talking machines of the sound-box and horn-type were sold in 1918. Over four hundred thousand were sold in 1919. In 1920 I think we came up to the five hundred thousand mark.

I heard of the Pathe Actuelle in 1918, 1919, or 1920. I never heard any discussion amongst the officers of the Victor Company as to any effect which the sales of the Actuelle machines were having on the Victor sales.

Cross-examination.

By Mr. Davis:

As I recall, the option with the Lumiere Company was taken up in the form of a license contract around 1909.

As to whether the Victor Talking Machine Company ever manufactured any phonographs with the Lumiere diaphragm and sold them,—I think that they had sent out a [fol. 59] few to the different foreign countries. To my knowledge they never sold any in the United States. I could not say how many they ever manufactured and sold. It was very few.

The first radio loudspeakers with the Lumiere diaphragm were made in 1925. They are still making them. They are called Victor loudspeakers.

The Victor Talking Machine Company is not manufacturing and selling devices with radio loudspeakers of any other type.

As to whether the Victor Company has recently offered on the market and has shown a phonograph combined with a radio loudspeaker,—I do not know of any exept the cone that we are placing in what we call our "Electrola" instrument. I would say that our Electrola instruments are the Deluxe latest model Victor Talking Machine Company instruments. They have a cone. The cone is not manufactured by the Victor Talking Machine Company. It is purchased from the Radio Corporation of America and manufactured by the General Electric Company.

I cannot say that I am familiar with the two types of radio loudspeakers that the Radio Corporation of America puts on the market under the numbers Radiola 100 and Radiola 104.

As to the size of the cone in the Victor Electrolas—if I recall, one is six inches and the other, I think, is thirteen inches.

As to whether the cones are supported around the edge by a flexible strip of leather fastened to the metal rings,—[fol. 60] I really do not know much about that. Mechanically I am not very keen on these things. I have not noticed them very much.

Mr. Davis: It is stipulated that in the Victor Talking Machine Company's product known as the Electrola, which is a combined phonograph and radio machine, the radio loudspeaker is either a Radio Corporation Radiola 100 or a Radio Corporation Radiola 104.

Mr. Scull: And that these loudspeakers are bought as part of the complete radio equipment from the Radio Corporation and this complete equipment is installed in the combined machine by the Victor Company.

Mr. Davis: And the loudspeaker serves as a loudspeaker both for the phonograph and the radio receiving set.

Mr. Scull: I will say that when the electrical pick-up is used in such a machine.

Mr. Davis: The electrical pick-up is a device by which the phonograph records may be utilized to actuate the electrically actuating mechanism of the loudspeaker.

I do not recall how many horn-type phonographs were sold by the Victor Company in 1921. As to whether it was less than in 1920,—I have not got the figures in my head. I do not really know. As to whether I know that the years 1918, 1919, and 1920 were the three biggest years the phonograph business ever saw,—I recollect that 1920 was the largest. The business of the Victor Talking Machine Com- [fol. 61] pany in horn-type phonographs in the year 1925 was not as large as other years. I think it was about four hundred thousand. I think it was around four hundred thousand in 1924. There has been a slight progressive falling off in the horn-type phonograph business since 1920.

As to whether the instrument which has been put in evidence as Defendant's Exhibit "A" came over to the laboratories of the Victor Company from France,—it was either brought over by Mr. Johnson or it was sent over. It was built in France by Lumiere or under his direction.

Redirect examination.

By Mr. Scull:

Horace Petit was the Patent Attorney for the Victor Company. He is now dead. The Mr. Johnson I have just referred to is the president of the Victor Talking Machine Company. He was president back in 1909. At the present time the Victor Company sells phonographs of the sound-box type with a horn, and without any radio attachment. That is the biggest product.

The Victor Company makes a machine in which there is both a phonograph horn and sound-box of the very old type, and also a radio cone loudspeaker. In the same machine there is incorporated a radio outfit. The radio reception is delivered through the cone loudspeaker and the mechanical reproduction from the record is delivered through the sound-box and horn. There is also in this machine a so-called [fol. 62] electrical transmission or electrical pick-up by which the phonograph record can also be transmitted to the cone loudspeaker.

Recross-examination.

By Mr. Davis:

As to how many radio loudspeakers with the Lumiere diaphragm the Victor Company have manufactured altogether,—I really think they manufactured about forty thousand. As to what month those loudspeakers were shipped out from the factory,—I think we started to make deliveries about December or January of 1925. No, I do not believe it was quite that early. I do not know whether the sales have been on the increase or decrease. The sales are not so high just at present. That is true of radio loudspeakers in general. It is a seasonal business. The company has not decided how many of these speakers with the Lumiere diaphragm they will manufacture for next year. They are manufacturing them now, but there has been no decision arrived at as to the quantity.

Deposition of Albert C. Diehl, for Defendant

(The deposition of Albert C. Diehl, included by the above-mentioned stipulation, reduced to narrative form is as follows.)

Direct examination.

By Mr. Scull:

My address is 229 North 39th Street, Camden, New Jersey. I am employed by the Victor Talking Machine Company and have been employed by them since 1899. I was [fol. 63] away a short while. The second reinstatement was from 1900.

I first saw the machine marked Exhibit "A," during the summer of 1910. The circumstances were as follows: I was called to help Mr. Elfering. He is now dead. I was called in to help him on some mechanical jobs. I have a machine shop and he having no machinery, I used to from time to time do his machine work for him and that is the time I saw his machine or one like it. I heard it played at that time. Mr. Eldering and Mr. Lumiere were present.

It seemed to me to have a clear, full tone. As to how it compared with the Victor talking machines that were being put out at that time,—I liked it. I thought it was a little more natural than our regular talking machines.

As to what Mr. Eldering was doing on this work, did not come in contact with him very often. He, so far as I know, was trying to arrange the machine so that it would be more convenient to get at the record by placing the diaphragm in a convenient position. I did not see very many of the experimental machines that Mr. Elfering made. I saw some. As to the difference between these machines and Defendant's Exhibit "A," so far as the diaphragm is concerned,—the diaphragm was always the same, as far as I know, with the exception that he was experimenting at times with different diameters of that small center, making it out of different materials, etc. and different diameters.

[fol. 64] Cross-examination.

By Mr. Davis:

As to whether I would say that the Lumiere speaker had less of a horny sound than the standard Victor talking machine,—I should say it was less sharp. More of a natural tone. It had more of the round, full tones, whereas the talking machines had more of a sharp, bright tone.

I did not know enough about it to know what a horn resonance is in these machines.

Deposition of Edward K. MacEwan, for Defendant (Recalled)

(At this point Edward K. MacEwan was recalled and testified further as follows:)

Direct examination.

By Mr. Scull:

At the present time the Victor Company is putting out a machine of the sound-box and horn type know- as the "Orthophonic."

As to the relative amount of business which the Victor Company is doing to-day in machines with the radio attachments about which I have testified and machines without such radio attachments,—the great bulk of the business is being done by the real talking machine with the Orthophonic horn and regular Victrola sound-box. That is not what I call an Electrola. The Electrola is the one with the radio combination. The other is the Orthophonic. The Orthophonic is by large the major portion of our business. [fol. 65] As to whether the Victor Company also makes a type of radio receiver in which they use a Western-Electric horn for the radio portion—I am pretty sure they do. That is the Orthophonic horn. With these radio receivers they are not using the cone loudspeaker. I cannot say what percentage of the total business in radio machines the Orthophonic horn type is. It is larger than the cone.

Cross-examination.

By Mr. Davis:

What we call the Electrola came on the market about February of this year. The price of Electrolas to the ultimate consumer is about four hundred and twenty-five dollars. There is another one about five hundred dollars and there is another one at about nine hundred dollars.

Deposition of Harry O. Sooy, for Defendant.

(The deposition of Harry O. Sooy, included by the above-mentioned stipulation, reduced to narrative form is as follows:)

Direct examination.

By Mr. Scull:

My residence is 265 Myrtle Avenue, Merchantville, N. J. I am superintendent of recording for the Victor Talking Machine Company. I have been employed by the Victor Talking Machine Company ever since it was organized. I started with Mr. Johnson before it was organized in 1898.

I have been connected with the recording department of the Victor Company since 1900.

[fol. 66] (The witness was shown a device and was asked if he knew what it was.)

It is a Stroh violin. This one, or one like it, was brought from Europe, I think, in 1903, by Mr. C. Childs who was then manager of the recording department. These violins were used by the Victor Company in 1904, and they have been used constantly since that time. As to its purpose,—we used it at that time because we could concentrate more direct to the recording horn the sound which we were trying to get on the records, while the regular violin spread in the air and we could not concentrate it to get it on the record strong enough. As to whether the device I have in my hand is the same as has been used by the Victor Company since 1904,—it may be one of them. It is either one of them or one exactly like it.

(The Stroh violin identified by the witness was offered in evidence as Defendant's Exhibit "B.")

NOTE.—The Stroh Violin is in evidence in this case as Plaintiff's Exhibit 33.

Testimony of Henry Stevens Tenny, for Defendant

HENRY STEVENS TENNY was called as a witness on behalf of defendant, was duly sworn, and testified as follows:

Direct examination.

By Mr. Loftus:

My name is Henry Stevens Tenny and I am president of [fol. 67] The Rola Company, manufacturers of radio loudspeakers.

The Rola Company has been engaged in the manufacture of Rola loudspeakers for about 4½ years, close to five years.

My first contact with electricity was as radio electrician in the United States Navy. I served four years principally in the Asiatic fleet and for about a year after being

discharged from the Navy I was Seattle manager for the Independent Wireless Telephone Company, which operated the radio installation on about three hundred shipping Board ships.

The Court: Have you any degree?
A. No, your Honor.

I have read and understand the patent to Maxwell No. 216,051 of June 3, 1879. I recently constructed a sounding board of that type. It is right there on the table. The actuating device which I applied to it is one of the large standard reproducing motor units that we use in practically all of our products.

Defendant's Exhibit 10.—The sounding-board identified by the witness is received in evidence as Defendant's Exhibit 10.

As to whether I made any other form of the Maxwell patent than the one I have just identified—I made one slightly simpler, one using a single side instead of the double side arrangement. (Witness identifies the modified form of Maxwell device made by him and referred to in [fol. 68] his last answer.) The actuating unit applied to the modified form of device is the same as in the other one.

Defendant's Exhibit 11.—The modified form of the Mexwell device is received in evidence as Defendant's Exhibit 11.

Defendant's Exhibit 12.—The patent to Dann & Lapp No. 338,660 of March 23, 1886, is received in evidence as Defendant's Exhibit 12.

I am familiar with the patent to Dann & Lapp No. 338,660, of March 23, 1886, and I have constructed a sounding board of the character shown and described in that patent.

The Court: What were these used for, this Maxwell patent and this one that you are talking about?
Mr. Loftus: This is for telephone purposes, and the Maxwell is for telephone purposes.
The Court: Proceed.

(Witness identifies the device which he constructed in accordance with Dann & Lapp patent.)

As to my understanding of the purpose of the device shown in the Dann & Lapp patent—it was a telephone transmitter, with features, particularly its diaphragm, which were applicable—and were so stated in the patent—to other telephony apparatus besides transmitters. Dann & Lapp's problem was to obtain a sufficient amount of energy from the human voice to operate the inefficient microphonic devices that were in existence at that time. The drawings of the Dann & Lapp patent show a telephone transmitter. As to whether I find anything in that patent [fol. 69] with reference to any other uses for the device there shown—on page 2, line 60, the patent reads: "Our improved diaphragm is applicable to other telephonic instruments beside transmitters." The only other telephonic instruments, besides transmitters that I am familiar with, that would be operative with sound waves in air are receivers or reproducers. The telephone receiver differs from the transmitter in operation only in the same way that an electric motor differs from an electric generator. A transmitter receives sound waves from the air, converts them into mechanical motion, and impresses them upon an electrical circuit, to vary the electric current in that circuit. A receiver is the exact opposite in its functioning, it takes the fluctuations of an electric current from an electric circuit, and converts them into sound waves in the air. In constructing the device which I have identified, I built it for receiving purposes.

Mr. Loftus: The device identified by the witness is offered in evidence.

Mr. Davis: I object on the ground that this is set up as part of the prior art; we have had no notice of it, and I do not see how the replica of the thing can be prefaced on the subject of the state of the prior act.

The Court: It will be received over the objection; if not competent the Court will ignore it in making up its decision. It will be in the record if the case goes higher. The [fol. 70] objection will be overruled.

Mr. Davis: Exception.

Plaintiff's Exhibit 13.—The device identified by the witness is received in evidence as Defendant's Exhibit 13.

As to the purpose of the sounding-board disclosed in the Maxwell patent No. 216,051—Maxwell's sounding-board is intended to function as does a telephone transmitter and a telephone receiver. He describes the use of two of his instruments which are replicas of each other, one used at each end of the telephone transmission line, and both used alternately or interchangeably as transmitters or receivers. The model that was offered in evidence was constructed for receiving purposes.

As to whether I have ever seen in use or on sale any sounding board of the type shown in Lumiere patents Nos. 986,477 and 1,036,529—I have seen a sounding board of that type on sale as a built-in part of the Victor loudspeaker that was marketed one or two years ago.

(Witness produces and identifies one of the devices just referred to.)

As to where I obtained this device—one of our employees bought it down town somewhere in Oakland. Its actuating unit is a Rola standard unit.

Defendant's Exhibit 14.—The device just identified by the witness is received in evidence as Defendant's Exhibit 14.

The Rola Company manufactures horns and cones and [fol. 71] also units, motor units with small diaphragms suitable for use with the air column chambers or cone chambers of phonographs. The conical sounding boards are mounted in three styles. We mount the unit in a circular baffle about 15½ inches in diameter, made of thick, hard wood; we also mount the unit and market it in a small cabinet about 12 inches in its over-all dimensions, and a third type is the same unit mounted in a large box which supported by four legs, and that box measures about sixteen inches square, and about eight or ten inches deep. (Witness is shown a device and identifies it as a Rola cone unit.) The Rola cone unit just identified is part of our product which we are manufacturing to-day.

Mr. Loftus: This apparently differs somewhat from the other device (Plaintiff's Exhibit 3) and I will offer this in evidence as Defendant's Exhibit 15.

Defendant's Exhibit 15.—The Rola cone unit identified by the witness is received in evidence as Defendant's Exhibit 15.

This device (Defendant's Exhibit 15) consists essentially of an electrical vibrating motor unit, which is attached to the apex of a cone approximately 7⅝ inches in diameter, of paper .0007 of an inch thick, and that cone diameter and paper, the material, the way it has been fabricated, have all been worked out over a period of several years to give a certain sound response when used in connection with this particular motor unit or electric vibrator, and in connec- [fol. 72] tion with the average radio set this device must be considered as an entirety, and not as a specific part. When this motor unit receives electrical pulsations, as, for instance, from a radio set, it converts those electrical pulsations into mechanical motion in the form of vibrations of varying frequency, and relative small amplitude. In use, that armature vibrates the apex of the cone to a distance not greater than .0015 of an inch. The result of that is to set up a series of waves of mechanical flexural vibrations in the conical-shaped diaphragm. These waves are extremely complex. When the instrument is used as a radio loudspeaker with the average radio set, the effect of these waves is to disseminate the energy that is received from the motor unit, which, in turn, has received it from the radio set; in other words, this device is a converter of electrical energy into energy in other forms. The effect of the vibration of this diaphragm by the motor unit results in converting part of that energy into sound waves in the air on both sides of the cone. It is possible, by suitable use and mounting of this device, to project a satisfactory proportion of these sound waves out into free air or free space. All of the energy that goes into the apex of that cone is not distributed out in the form of sound, in fact a very insignificant portion of the energy goes out, which is true of all sounding-boards. The rest of the energy, which is in the form of flexural vibrations, is absorbed, in a small measure, through the fric- [fol. 73] tional rubbing of the particles of the paper against each other; the balance is absorbed by the frictional effect of the limp leather ring at the periphery of the cone; in other words, electrically, we vibrate the whole power into

the box, some of that power is transmitted out in the form of waves, and the rest is absorbed in small part, in the cone, and in a great part through the absorbing action of that soft leather. This cone, like all sounding-boards, responds more readily to some tones or frequencies than others. Our problem is to compensate this response and offset it, as far as we can, by an opposite characteristic in our unit, and also by applying further frictional drag upon the motion of the diaphragm; in other words, the unit not only sets the cone into operation, into vibration, but the rest of the device controls that vibration to prevent setting up resonance to prevent blasting. An important part of this additional action is accomplished by the use of the thin felt covering which surrounds the back of the cone, and is separated a short distance, an inch or so from the cone. When the cone vibrates and moves the air, it has to pump the air which is on the back of the cone through the meshes of that felt; atmospheric air is at a pressure of approximately 15 pounds per square inch; consequently, for every motion, no matter how small or large, of the cone, we have a positive motion of air through this felt. In passing through the meshes of the felt, the air is restricted in its passage, and heat is generated in the felt, which dissipates additional [fol. 74] energy from the cone, and the result of this construction is we have a reproducer in which we can produce immediately adjacent to the front of the cone sound waves with relatively small variations in amplitude of all frequencies within 100 cycles per second to about 5,000 cycles per second.

To prevent frequencies above 5,000 cycles per second from being generated, we introduce into the electrical system an electrical filter, which prevents any current above 5,000 cycles per second from passing into the reproducing motor.

Q. Does that leather band at the base of the cone form any part of the sounding-board or tympanum?

A. Only in a very minor and imperceptible sense. The leather, while it has a certain amount of rigidity, its rigidity is absolutely insignificant compared to the greater rigidity of the cone diaphragm. In other words, when the cone moves forward, for instance, it will drag a very small por-

tion of that leather forward with it, but the rest of the leather, because of its inertia, and because of the pressure of air, will lag behind, and stay more or less permanent.

As to what portion of the entire diaphragm is depended upon for the reproduction of these sounds—the reproduction of sounds is confined almost entirely to the paper conical portion, and to perhaps one-eighth of an inch of leather contiguous to it. The diameter of the entire diaphragm from one edge of the frame to the other is about 8½ inches. [fol. 75] That is the only size of diaphragm that we employ in our construction of the cone. We have never constructed any larger than that for commercial manufacture.

The device that I hold in my hand (Defendant's Exhibit 15) is operative to reproduce the character of sounds that are required for commercial loudspeakers, only in a very limited sense and in a feeble degree. This operates over a certain band or range of tones, but not over the entire range of tones that is demanded by the market or the public that buys this quality of instrument. Due to the small diameter of that cone, when it moves forward it pushes the air ahead and it drags the air back with it. That air ahead merely slips out, down the outside of the edge, and back. The result is when the cone moves forward the percentage of sound radiated into the air is lessened because the air pressure or air wave which would form a sound in front is met by an air wave of opposite polarity back of the base of the cone. On a cone of this diameter, we have found this radiation would be limited to about 250 cycles per second; in other words, if the cone vibrated to a lower vicinity than 250 cycles per second, the dissipation of energy through the free passage of air around the edge of the cone would prevent a satisfactory radiation of those tones into the free air. A loudspeaker, in order to be satisfactory under present conditions in the reception of broadcasting should cover with reasonable efficiency, the frequency range of the broad- [fol. 76] casting station it is used with. We have found that broadcasting stations transmit with good fidelity all tones from about 100 to slightly over 5,000 cycles per second. As to how we make this small cone diaphragm operative to reproduce these low frequency tones—the cone itself, reproduces them. The problem in the use of the cone is to radiate these tones out into the air. We found that we radiated these tones satisfactorily by using the flat baffle

surface, with a box-like structure, which will entirely, or almost entirely, separate the cone, or at least separate the front of the cone from the back of the cone.

Q. In connection with the defendant's device, you mentioned a flat baffle, and I will ask you if such a flat baffle is represented in Plaintiff's Exhibit 3 as being one used in connection with your cone.

A. Yes.

Q. You also mentioned a cabinet as forming another type of baffle, and I will ask you if this structure which I show you is such a cabinet.

A. Yes.

Defendant's Exhibit 16.—The cabinet identified by the witness is received in evidence as Defendant's Exhibit 16.

Q. Did you ever sell these cone speakers without the baffle or the cabinet, that is, for use, without a baffle or a cabinet?

A. We have sold a considerable quantity of them to radio set manufacturers, and furniture manufacturers, who [fol. 77] mount them in various types of cabinets.

Q. But are they for use without the flat baffle or cabinet in practice?

A. There is nothing that would prevent them from the use of that, but I have never known of an instance of it.

Q. Have you ever heard of such use?

A. No.

The reason for employing a conical form of diaphragm rather than a flat diaphragm, for instance, is that a cone is a mechanical structure embodying great strength, with an economy of weight. It gives a convenient structure for getting strength without getting undue weight. In generating sound, where you have a very light substance in the form of air, we try to cut the mass of our vibrating diaphragm down as close to that air as we can. As to whether there are other ways of getting this rigidity than by conical forms,—the sounding-board of a piano is a thin sounding-board of wood, reinforced with a series of transverse members or battens, giving a very rigid, light system. A very rigid, light system could be made in the same way by using even lighter wood than is used in pianos, and a loudspeaker could be developed in the same way as it was done by

Lumiere (Defendant's Exhibit 14) in pleating the paper and getting the strength by the edgewise use of the paper. These pleats provide the rigidity. As to whether there is any acoustic advantage in the cone device, aside from the fact that it provides inherent rigidity—there is an acoustic [fol. 78] disadvantage because of its conical shape, but no acoustic advantage. A cone, in one sense of the word, is a modified horn, it is a small horn, and while the frequency natural to that shape of horn and that size like that would be very high, a noticeable defect developed in this; the cone will tend to radiate an excessive amount of sound at a particular frequency where that horn effect begins to operate.

I am familiar with the Hopkins' patents in suit. I have constructed a sounding-board like the Hopkins' patent in size comparable with the Rola loudspeaker.

(Witness identifies the sounding-board so constructed.)

The operating unit in this device is the standard Rola motor unit.

Defendant's Exhibit 17.—The sounding board identified by the witness is received in evidence as Defendant's Exhibit 17.

As to the structral differences and the differences in operation and effect as between the defendant's device and the device shown in the Hopkins patent in suit—both devices generate the sound at the apex of the cone, and in substantially the same manner. The sound vibrations are applied at the apex of the cone and set up flexural wave vibrations which radiate out from the apex from the cone to its edge, to its periphery. In the Hopkins construction he makes the periphery flat to form an annular rim and clamps it to a rigid frame of large mass. In our construction we interpose a flexible yielding and resistive membrane of kid [fol. 79] leather between the edge of the cone and the supporting rim. When considerable power is applied to a Hopkins type of cone, when it is made of small size, the energy that is applied to the apex is like all sounding boards, not entirely radiated off in the form of sound. It stays in the cone until at certain frequencies it increases to such an extent that it produces blasting and rattling. We have presumed that the rigid clamping around the edge of the cone was intended to prevent that rattling by rigidly

holding them, and we found that it does not prevent it, but only raises the frequency at which the cone will rattle. It increases the rigidity of the whole system, but it does not do anything to dispose of the energy which is the cause of the rattle. Our kid membrane is a flexible resistive material, which to a greater extent insulates the edge of the cone from the supporting rim. When sound vibrations reach that flexible kid membrane, the softness and yielding qualities of it cause it to absorb a great proportion of that sound, and cause it to absorb and prevent the bulk of that rattling. Our problem was to design a structure which would have the ability to radiate the desired frequency, and also to provide in the design a frictional control to control the amplitude of vibration that was built up in the cone. In the Hopkins structure, there was no such provision for control. In the Hopkins patent I find a provision for a baffle-board or other baffle effect, only in a very slight effect due to the iron [fol. 80] rings, but those rings are of rather small cross-section compared to their diameter.

I would say from my experience in this art that the smallest diameter that could be employed with success following the Hopkins construction, and getting the results that are required in actual practice in broadcast reception, would be about 20 inches—18 to 20 inches. The reason for that is we found that a baffle of about three feet square insulates the back waves from the front waves, at all frequencies used in broadcasting, that are transmitted to the average receiving set. However, we also found that a baffle three feet square was a cumbersome and unwieldy piece of furniture, and we trimmed the size of that baffle down to the smallest we could get, which we finally adopted at 15½ inches. I believe that a cone, to have an equivalent radiation effectiveness, would have to be at least as large as our baffle, and preferably larger than our baffle, and for the same reasons, that our baffle would be better if it would be larger.

In constructing a cone of less than nine inches in diameter, according to the Hopkins drawings and specifications, and without using the baffle, I noticed in operation that it tends to over-emphasize the higher-pitched notes. There is also a loss of radiation of sound. The loss of radiation of sound shows itself as a rattling tendency; in other words, the Hopkins cone of nine inches or smaller will

rattle very freely. If put into a baffle, it will not tend to [fol. 81] rattle quite so freely. More power can be put through it without getting the paper rattle.

In regard to the leverage employed in our device, Exhibit 15, in this model which I have been making and standardizing on for six months, the motion of the cone is greater than the motion of the armature. That is not true of the device which was introduced in evidence as Plaintiff's Exhibit 3. Plaintiff's Exhibit 3 is a cone that we manufactured over two years ago and in which we used a coupling between the motor unit and the cone which gave the cone a slightly smaller amplitude of vibration than that of the armature.

Referring to the British patent to Brown, No. 29, 833, the leverage therein imparts a shorter movement to the cone than the movement which is impressed upon it. As to the condition in regard to the leverage in Lumiere patent No. 986,477—I would have to scale this to make absolutely sure, but to the eye it looks like a very slight stepping down; in other words, the distance from the fulcrum to the needle point is a little greater distance than it is from the fulcrum to the end of the needle which connects to the diaphragm.

Q. Have you facilities here for demonstrating the operation of these various devices which have been offered in evidence and identified by you?

A. Yes. We have an electrical pick-up.

Q. Is there any question that they all operate?

A. No.

Mr. Loftus: I imagine the plaintiff will contend that these [fol. 82] models of the early patents are inoperative, and I want to make a demonstration of that. We have facilities present here.

Mr. Davis: I would not expect them to be inoperative; whatever these gentlemen have made up, I assume that they were made so that they will work.

The Court: That is what they were made for, I suppose.

Mr. Davis: I suppose so.

Mr. Loftus: There is one other demonstration, I think, which is quite important.

The Court: Proceed with it briefly.

Q. Will you kindly demonstrate this device which has been offered in evidence as Defendant's Exhibit 17, which

represents the Hopkins construction in small size, and compare the same in operation with the Rola cone, both without and with a baffle.

The Court: Can it be done briefly, Mr. Witness?

A. Yes.

The Court: Do not take long.

Mr. Davis: As I understand it, they have made up some device which is different from the Hopkins patent, and now they are going to demonstrate that. I do not see the pertinency of it.

The Court: It is part of their case.

(Witness demonstrates Defendant's Exhibit 17.)

That test showed to us that at the proper time, this disphragm, notwithstanding the fact it is rigidly clamped and [fol. 83] built according to the Hopkins patent, will rattle and blast. The cause of the rattling is inefficient damping, in other words, there is more energy going into the cone than can be radiated off in the form of a column, with the result that it fills up on certain notes and snaps the paper and rattles. We eliminate that in part by a leather edge, and also by the use of felt covering the aperture around the cone to restrict the flow of air. As to whether the presence or absence of a baffle would enter into that—a baffle will minimize the rattle to a slight extent.

Q. Will you kindly demonstrate the Defendant's device both with and without the baffle?

A. Yes.

(Witness demonstrates Defendant's Exhibit 15 without a baffle.)

According to that test, our device on the same input does not rattle, either with or without the baffle, whereas the Hopkins device would rattle upon that in-put. We have found by tests in our laboratory that upon applying still greater power the one without the baffle will rattle, but at that rate of power the one with the baffle will not rattle. The test also shows us a much deeper and rounder tone with a baffle cone than from a cone free and without a baffle. That test as to the difference with and without a baffle would be more pronounced with a larger baffle.

Q. Have you such a larger baffle, so as to accentuate the difference in the function and advantage of the baffle in a larger size.

A. Yes.

[fol. 84] (Witness demonstrates Defendant's Exhibit 15 when supplemented by a larger baffle.)

That test showed a noticeable increase in volume with the baffle and a much better reproduction at a lower frequency.

As to whether I have any tests that will more clearly accentuate the rattling effect which will be developed by a cone such as Defendant's Exhibit 17 and our own device, Defendant's Exhibit 15. We have an electrical device for generating a pure tone of any desired frequency within the broadcasting range; in other words, between 100 and 5,000 cycles a second. I can connect that device up and put a constant tone through any speaker and operate it, and by properly watching these tones I can demonstrate the frequency at which the various speakers will rattle. The implement that I employ for that purpose is what we call a beat frequency audio oscillator. It consists of two vacuum tubes, both oscillating at a very high frequency, and a frequency so high that they are inaudible to the ear, and by varying the frequency of one of the tubes we vary the corresponding beat frequency between the two tubes.

If one tube has a frequency of 45,000 oscillations per second and the other 46,000 the note generated by the oscillator will be the difference between them or 1,000. By varying the frequency of one of the tubes, we vary the corresponding beat frequency between the two tubes. I can start the [fol. 85] frequency at zero and bring it up continuously, zero meaning no frequency at all.

(Witness demonstrates Defendant's Exhibit 17, in connection with the beat frequency audio oscillator.)

The cause of that rattling or squeaking is the snapping of the paper at the end of the cone, due to the fact that there is insufficient provision for drawing the energy away from the cone that is applied into the cone. The energy expends itself in part by snapping the paper.

Q. Can you make that same test on the Rola cone, Exhibit 15?

A. Yes.

(Witness makes the same test on the Rola cone Defendant's Exhibit 15.)

The frequencies used in this test cover a range from zero to about 8,000 per second. As to whether I noticed any rattling or speaking—I noticed a very slight resonance effect, but no blasting. The reason for that is because we have absorbing facilities in this construction, in the form of an absorbing rim, and a felt damping exit for the air behind the cone. In other words, we dissipate mechanically the surplus energy out of the diaphragm.

Q. Will you operate this Lumiere device and compare that with the model of the Hopkins cone that you operated awhile ago?

(Witness demonstrates Defendant's Exhibit 14.)

This one blasts, but it is not the diaphragm blasting, it is due to the fact that this motor unit is not fitted to driving [fol. 86] that form of diaphragm, the armature vibrating such a great distance at exereme power. We could correct that by placing the unit to match that particular form of diaphragm.

Q. Will you operate Defendant's Exhibit 13, which you state is a model of the Dann and Lapp patent?

A. Yes.

(Witness demonstrates Defendant's Exhibit 13.)

The device suffers from the same fault as the Hopkins construction, in that there are not sufficient damping facilities on the diaphragm. In constructing this, we followed, as closely as we could, the specification of the original patent. We could improve its performance by providing somewhat greater number of felt bands resting on the diaphragm and damping out the surplus energy which produces a slight rattle.

Q. Will you operate this Maxwell device, Defendant's Exhibit 10?

A. I would like to say that this device has been damaged in handling in bringing it over here, and in order to make it operative I will have to put a slight tension on the me-

chanical parts back here. The part that supports the unit has been bent in. By holding it in my hand without touching any other part of the device, it will hold the unit in position.

(Witness demonstrates Defendant's Exhibit 10.)

That seems to reproduce in the same manner as all cone type loudspeakers; this particular model suffers because it has been slightly buckled—we corrected that when we made a later model. This slight buckling in the cone sur- [fol. 87] face produces that very faint sound with certain tones. As to what elements enter into that sounding-board construction, we have the cone, we have a tympanum consisting of a flat annular surface with the center cut out, and to which fitted a cone made of rawhide. This particular model is made of a banjo head, which we purchased flat and which we made into this shape in accordance with the patent to Maxwell. The diameter of the base of the cone is exactly the same as our regular cone, 7⅝ inches. The Maxwell patent specifies a diameter of between 7 and 8 inches.

Q. Have you completed the operation of the modified form of Maxwell?

A. Yes.

Q. You may state now your reason for constructing it in that form.

A. Maxwell uses two diaphragms, one on each side of the box; we are only interested in one, because we are interested in duplicating the sound in one direction, only. Therefore, in this box we have left off the back diaphragm, connecting the unit directly to the other one.

Q. Is it essential to the operation of the Maxwell patent that two diaphragms be employed?

A. Oh, no.

Q. What is your reason for saying that?

A. Well, he actually only employs one as a device for picking up sound waves. In other words, in the Maxwell construction we have two devices connected together by a string to comprise the mechanical telephone system; you [fol. 88] talk into one and you hear it in the other; you only talk into one diaphragm; the other diaphragm on the other

side was inoperative, and merely sufficed in the way he built his diaphragm——

Q. Can you operate that device for us?

A. Yes.

(Witness demonstrates.)

This device is superior in over-all performance, to our minds, than the equivalent Hopkins construction, in that with the use of this larger surface there is more radiating surface, and, consequently, more baffle. The use of the thin wood gives a better form of tympanum than paper, in that the wood, having thinness and softness to it has an internal friction within itself which tends to absorb and damp out the surplus energy of the cone. For that reason, this construction will not rattle with power, as will easily rattle this construction.

On the model of the Dann and Lapp patent, the diameter of the cone is about four inches. As to how we arrived at that size—the patent was not clear as to the size of the cone used, and I tried to approximate the size that was intended by the original inventor, by analyzing the problems that they had before them: in those days there were no highly sensitive microphone devices, such as we use nowadays in telephony. Their problem was to obtain a larger amount of energy from the voice to operate an insensitive microphone and from reading that patent through I got the impression that what they thought and what they did have in [fol. 89] view of accomplishing was a means for getting a lot of energy out of the use of a comparatively large diaphragm, in which they got stiffness by having part of it in a conical shape.

Q. Do you find that a cone of that size will reproduce these so-called self-sustaining sound waves without the aid of a horn?

A. Oh, yes.

Q. That was demonstrated here in the test when you removed the horn, was it?

A. When I removed the horn it changed the directivity of the sounds, but not their intensity; there was a difference which was very imperceptible.

Q. Can one of these loudspeakers be used as a transmitter?

A. All of them can.

Q. How is that done?

A. In the same way that the original Bell telephone was both a transmitter and receiver; a loudspeaker, in the final analysis, is only an overgrown telephone receiver. It does exactly the same thing that a telephone receiver does, in that it converts electrical energy into sound energy, and, inversely, if you talk into a loudspeaker, you will generate an electric current in the winding; in the same way, when you talk into Professor Bell's telephone receiver, it acted as a transmitter. The first Bell telephone system was two receivers, one at each end of the line, which acted both as transmitters and receivers.

Mr. Loftus: That is all.

[fol. 90] Cross-examination.

By Mr. Davis:

Q. Mr. Tenny, I understand that you started in this business with the Rola Company about four and a half or five years ago?

A. Yes.

Q. You were making horn loudspeakers, at that time?

A. Yes.

Q. Were not making cone loudspeakers?

A. No.

Q. When did you start making cone loudspeakers?

A. About two and a half years ago.

Q. Were you then still making horns at the time you started making cones?

A. Yes.

Q. Do you continue to make horns to-day?

A. Yes.

Q. Will you give us some idea of how the manufacture of cones has grown in quantity in your business, as compared with the sale of horns?

A. In the United States the manufacture of horns has diminished in number of horns, but I do not believe that it has diminished, at least, until the last month or so, anyway, in the dollars and cents value of the horns produced.

Q. The question was about your business, Mr. Tenny.

A. In our business, we decided at the height of the cone popularity, instead of manufacturing the type of horn which then was desirable, which was a long horn, to restrict our efforts to the manufacture of cones in order to simplify [fol. 91] our line. The result is, we sell very few horns at the present time in comparison with the number of cones sold in the United States. In Japan we sell nothing but horns.

Q. That is, as I understand it, at some period of time you made this decision that you speak of—what was that period of time?

A. That was at the time the Western Electric Speaker came out and practically killed the horn business.

Q. This Western Electric speaker that you have been talking about is of this type that I have in my hand, and that is marked in this case, "Western Electric Speaker," held not to be an infringement in Lektophone vs. Western Electric?

A. Yes.

Q. What date was that?

A. I don't remember exactly, but my recollection is that it was about three and a half years ago that the Western Electric cone came on the market; it followed several other cones which had come on, and left apparently no impression on the market, one of which was the Pathe cone.

Q. What I am trying to get at is the date; I asked you what date it was.

The Court: About.

A. The date the Western Electric came on the market?

Q. The date that you made this decision, when you say you decided to stop making horn loudspeakers and devote yourselves to making cone loudspeakers?

A. It was in December, 1924.

Q. You said that you made that decision in preference to [fol. 92] modifying your horn. What did you mean by that?

A. The public demand grew for low notes, which could be obtained by lengthening the horn, which has been done in the Victor Orthophonic phonograph; that brought the horn into a higher classed price of merchandise, and we decided to make the cone, which would accomplish, to a certain extent, the same purpose.

Q. As I understand it, you sell to the trade today, or have sold to manufacturers of radio receiving sets, mechanisms like Plaintiff's Exhibit 3?

A. Yes.

Q. That is, by outright sale, and you retain no control over what they do with them after they get them?

A. Yes.

Q. You spoke, Mr. Tenny, about the effect of the felt which appears on Defendant's Exhibit 15; you spoke of that at some length, didn't you?

A. Yes.

Q. There is no such felt in the device like Plaintiff's Exhibit 3?

A. No.

Q. When did your company begin putting that felt on these devices?

A. About December, 1927.

Q. You understand, do you not, Mr. Tenny, that the flexibility of the supporting rim of these cone loudspeakers has something to do with how well they operate?

A. Yes.

Q. Now, referring to Defendant's Exhibit 17, as I understand it that device you made up by first making a cone the [fol. 93] size of the defendant's cone in its regular speaker, that is having a diameter of 7.5 inches at the base—is that right so far?

A. Slightly greater than 7.5.

Q. And then you supported that in rings. How did you determine the diameter of those rings?

A. The inner diameter is about the same as the outer diameter of our present felt support, our present leather support.

Q. Then you bridge the distance between the edges of the cone and the clamping ring by this flat paper rim?

A. Yes.

Q. Thereby making a flat paper rim of the same width as your flexible leather rim?

A. Yes.

Q. And in doing that you support this cone by a rim which was narrower than the Hopkins patent indicated, didn't you?

A. I am not just sure what Hopkins indicated.

Q. I will put it this way: If, instead of using this narrow paper rim, if you had made the over-all diameter of the ring 9 inches, and kept the cone the same size that you had it in this Exhibit 17, you would then have a wider flat rim than you now have, would you not?

A. Yes.

Q. And that wider flat rim would have been correspondingly more flexible, would it not?

A. Yes.

Q. Have you ever made up any devices with a cone of exactly the same size as the cone in defendant's device, with a supporting rim of the same material, but made correspondingly wider, so as to get the greater flexibility, and tried to find out whether such a device would have this blasting?

[fol. 94]

A. We did not do that, because we did not want to follow that line of work, because it might infringe existing patents.

Q. Now, in this Maxwell device, which is Defendant's Exhibit 10, please direct your attention to that and turn to the Maxwell patent; as I understand it, your device, Defendant's Exhibit 10, is intended to be a replica of what is shown in Fig. 1 of the Maxwell patent?

A. Yes.

Q. Did you ever attempt to make a replica of what is known as Figure 2 of the Maxwell patent?

A. No.

Q. You understood, did you, that it is of the device shown in Fig. 1 that the patentee speaks in the first column of the specification?

A. Yes.

Q. And that the invention of the patent No. 216,051 is the device shown in Fig. 2?

A. Yes.

Q. Then, as you understand, when the patentee says, "Now, my invention herein claimed relates to the construction of a vibratory apparatus of quite different form and of a much better result from the one hereinbefore described," he meant that the device of the much better form was the device of Fig. 2?

A. Yes.

Q. In your Exhibit 10, are the vibrators stretched and held taut by means of buttons?

A. On the wire, as in the Maxwell Figure 1, there is a wood button on one side, and a small metallic cap on the other side, but it is in the same position as the wood button. [fol. 95] The wood button would function exactly the same way.

Q. Are they stretched and held taut?

A. Yes.

Q. Are they such a material that but for the buttons and the wires stretching them taut the vibrators would collapse when the wire was relaxed?

A. What you have just read refers to the second invention, not to the construction we made.

Q. What I have just read is from the second page, first column of the patent, where Maxwell says, "The vibrators are stretched and held taut by means of the button e the wire T; and but for the button i on the wire outside of the box, the vibrators would collapse when the wire was relaxed." Now, I ask you if the vibrators in your Exhibit 10 would so collapse when the wire was relaxed?

A. The vibrators on this will not collapse when the tension is relaxed.

Q. Do you understand what Maxwell says or meant when he said in the following paragraph: "In this construction it will be observed that a larger portion of the appartus is made of the sheepskin or other animal membrane, and there is in it no more wood, which is itself, capable of a high degree of vibration, than enough for a frame to hold the vibrators in position and in proper shape, and that it is, therefore, very efficient for the purpose of condensing and strengthe-ing air vibrations for transmission."

A. That is true of Figure 2, but this is made in accordance with Figure 1.

[fol. 96] Q. You understand his idea in the construction of Figure 2 was to reduce the wood to a minimum?

A. Absolutely.

Q. And that, for the purpose of condensing and strengthening the air vibrations?

A. That was to reduce his mass.

Q. So that, when he talked into the hollow chamber of Figure 2 he would get a better transmission?

A. For his purpose he would probably get it.

Q. I want to have it appear in the record, if you will help me, that when you were testing the defendant's speaker with the baffle, the thing you were testing was Defendant's Exhibit 16, in which the baffle is in the form of a cabinet; that is right, is it not?

A. Yes.

Q. As I understand, you agree that in these cone devices, if there were no support for the edge of the cone, and then you vibrated it with these sound currents, as you have done here in your exhibition, you agree that the edge of the cone would then weave and rattle?

A. Not necessarily, no.

Q. What do you mean by "not necessarily"?

A. Because it is a very simple matter to build a cone that would not weave and rattle, within the same range that that won't weave or rattle.

Q. By "that" you mean Defendant's Exhibit 3?

A. Yes.

Q. Of the same size?

A. Of the same size.

Q. What sort of paper would you use?

A. I would use a thicker paper; I would slightly cor- [fol. 97] rugate the edge of it; that is assuming that it is operated in absolutely free air.

Q. Let me put it this way: If you take the rim off of this device, Plaintiff's Exhibit 3, the edge of the cone would weave and rattle when subjected to the energy that this device Exhibit 3 is subjected to in practice, would it not?

A. I presume it would. I would not say.

Q. You agree that the effect of the flat rim which extends from the cone to the frame, is to prevent such weaving and rattling?

A. To absorb the surplus energy from the cone.

Q. Now, you could prevent any weaving and rattling of the edge of the cone by fixing it rigidly to a frame, could you not, without any interposed flexible rim?

A. No. The cone will rattle at higher frequency. You merely pitch up the rattling point.

Q. Why don't you support your cone by a rigid frame clamped directly to the edge of the cone, instead of having this interposed flexible rim?

A. To enable the cone to vibrate freely and move freely.

Q. That is, if the edge of the cone was supported to a rigid structure it could not vibrate freely, and could not produce sound freely: Is that true?

A. It could produce sound at certain frequencies.

Q. But not low?

A. But not the lower frequencies.

Q. You spoke about the energy consumed in the opera- [fol. 98] tion of these devices. Now, as I understand it, when you move this cone back and forth aga-nst the air, there is a consumption of energy by the movement of the cone against the air: That is true, is it not?

A. Yes.

Q. And at least part of that energy becomes sound waves: That is true, is it not?

A. Yes.

Q. And I suppose to whatever extent the rim moves there is some similar consumption of energy: Is that right?

A. Yes.

Q. And then, as I understand it, you say this energy is absorbed in the band of this leather rim of your: Is that right?

A. Yes.

Q. There is also energy absorbed in the band of the paper of the cone itself, isn't there?

A. Yes.

Q. Have you made any measurements from which you can say what part of the total energy is absorbed by each one of these different things?

A. I have not, no.

Mr. Davis: That is all.

Redirect examination.

By Mr. Loftus:

I was asked about a free-edged cone on cross-examination. As to whether I have constructed such devices and tested their operation—we have constructed a cone in which the edge was not rigidly clamped. It functions practically, in fact, absolutely the same as our standard construction. I have such a device here.

Defendant's Exhibit 18, device produced by witness, is received in evidence as Defendant's Exhibit 18. In this [fol. 99] exhibit the cone is supported as follows:

The cone has pasted to its edges the annular rim of thin kid, at the outer edge of which is sewn a very light aluminum ring; that ring serves the function of holding the kid in approximately flat shape, and holds it all in one plane. That ring, in turn, is supported by three very small threads about three-quarters of an inch long, leaving the ring entirely free.

Mr. Loftus: That is all.

Recross-examination.

By Mr. Davis:

Q. Mr. Tenny, I have in my hand the loudspeaker portion of a Radio Corporation of America Loudspeaker 100A; do you recognize it?

A. Yes.

Q. That cone is made of paper, and it has corrugations, concentric corrugations in the body of the cone, and I notice that you have concentric corrugations in the body of your cone. Have you put your concentric corrugations in after the Radio Corporation came out with this 100A?

A. Yes.

Q. I notice that the 100A has felt covering the openings in the supporting frame: Did you also put felt in your speakers after they came out with this felt?

A. Yes.

Mr. Davis: That is all.

[fol. 100] Testimony of Peter L. Jensen, for Defendant

Peter L. Jensen was called as a witness on behalf of defendant, was duly sworn, and testified as follows:

I reside in Alameda, and am engaged in the manufacture of radio loudspeakers. In 1902 I obtained a position with Vladimir Poulson, who was the inventor of the system of

wireless telegraphy, and I was with him until 1909, after he engaged in wireless telephony and wireless telegraphy; and in 1909 I came to the United States and was actively engaged here in radio telephony, and since 1911 I have been engaged in the manufacture and experimenting with telephones, particularly loudspeaking telephones, except for a period from 1925 to 1927, when I was not doing anything in this line. I was chief engineer of the Magnavox Company from 1911 to 1925. I was one of the original patentees of the Magnavox loudspeaker. The name of the concern I am now connected with is the Jensen Radio Manufacturing Company.

As to my understanding of the term "tympanum" as used in the telephony art—a tympanum is, according to the understanding among acoustic and telephone engineers, a stretched diaphragm which will emit a soundwhen vibrated. The tympanum of Defendant's Exhibit 15 is the stiff part, which, in this case, is the paper. As to whether the kid [fol. 101] leather band is a part of the tympanum—if I were speaking to a body of acoustical engineers,or electrical engineers, and tried to tell them that this was a tympanum, that soft kid leather, I think they would smile at me.

The purpose of the soft kid leather is to hold the cone in position, and also to prevent the sound from the front part getting over to the back of the cone. The effect when the sound from the front gets over to the back of the cone is that it eliminates or kills off the low notes.

The device that I hold in my hand (Defendant's Exhibit 15) is not in my opinion a complete loudspeaker, such as could be successfully marketed to people who employ them for the reception of radio broadcasting. A baffle is lacking on it. It would not be commercial under any circumstanes. A baffle is a medium which you put around the cone and it prevents the waves emitted from the front from reaching the back, due to a compression on the front at the same time as a rarefaction on the back of the cone.

I have had several years of experience with baffles in connection with loudspeakers. I have found that in order to have a loudspeaker of this type operate properly, the baffle must be one-quarter of the wavelength of the sound emitted. that is generally accepted by the engineers. The reason for

that is this: by the time the wave which is emitted from the front reaches the back, no rarefaction must exist, the cone must move back so there is no back action, otherwise the air [fol. 102] would tend to creep in. As to how I would arrive at the proper size for a baffle in a cone like that—in some of the best commercial loudspeakers to-day we have found it necessary that they should reproduce down to about 64 cycles per second, which is two octaves below middle C. That would require a baffle four feet in diameter. That is determined because it is two feet from the front to the edge of the baffle, and two feet down to the back. The baffle can be in the form of a cabinet as long as the total distance is four feet.

As to what is the reason for employing a conical form of diagram in these loudspeakers—it has been known for a great many years that to get a very light tympanum it ought to be made into a conical shape, to give strength. This was used in the old mechanical telephones, which were even used before the invention of the telephone in 1876. There might be other ways to get the lightness and rigidity aside from the cone, but generally a cone is used because it is such an old and well-known device. That rigidity is approximated in a pleated structure like Defendant's Exhibit 14. Considered purely from the acoustic standpoint, there is no merit in the cone over any other shape of diaphragm as long as the weight is approximately the same.

As to whether I am familiar with any of the old telephone patents, where they employed conical diaphragms—I am familiar with the patent issued to Dann and Lapp, No. [fol. 103] 338,660, over 40 years ago. That, in my opinion, is such a device as could be used successfully as a loudspeaker. My reason for that opinion is that I have heard one operate. As to whether the patent has anything to say about loudspeakers—it mentions in here, that particular word. (Witness reads from the patent:) "The object we aim at and have attained is the production of a loudspeaking instrument." I think perhaps that is the first time that a loudspeaker is used in the art, 42 years ago.

Mr. Loftus: That is all.

Mr. Davis: No cross-examination.

Testimony of E. G. Danielson, for Defendant

E. G. Danielson was called as a witness on behalf of defendant, was duly sworn, and testified as follows:

I reside at 945 Faxon Street, San Francisco. I am engaged in the manufacture of radio parts. I have been connected with the radio industry for 23 years—nine years in a commercial way. As to what experience I have had in radio or kindred arts, such as telephony,—I have had 15 years experience with the production and manufacture.

I do not know what the expression "tympanum" means in the telephony art.

Q. You cannot give us a definition of "tympanum"?

A. I can give you my understanding of it.

[fol. 104] Q. What is your understanding of it?

Mr. Davis: I object to that——

The Court: He may state. Objection overruled. Aren't there definitions of the word in dictionaries, or encyclopedias?

Mr. Loftus: Yes, but I am bringing out from the witness his understanding of the meaning.

The Court: Proceed.

A. My understanding of it is that it is a stretched diaphragm, similar to a diaphragm on a drum, and when it is vibrated it emits a sound.

I would not classify the limp leather portion in Defendant's Exhibit 15 as a tympanum. As to the function of the limp leather portion—I would say that it is to support the cone and to prevent the slippage of the cone, or in other words, prevent the energy created at the back of the cone from counteracting the energy created at the front of the cone.

The device which I hold in my hand (Defendant's Exhibit 15) as it stands, is not an operative structure such as could be successfully marketed, because it would not reproduce with efficiency low frequencies, for the reason that the energy from the rear of the diaphragm would counteract so much of the energy from the front of the diaphragm. The general way to correct that it to use a baffle-board. My idea

of a baffle-board is some material interposed on the center line between the rear and the front part of the cone, to lengthen the path. It is not necessary in the larger sizes [fol. 105] of cones to employ these baffle-boards. The reason for that is that the cone itself acts as a baffle-board. The bulk of the energy is transmitted from the central portion, the remaining portion acting as a baffle.

The particular area of the cone which functions normally to give off the vibrations and the distance from the apex which these vibrations ordinarily extend, in the lower frequencies, depends on the amount of energy put into the cone and the thickness of the cone. With the average cone, under normal use, in broadcasting reception, the bulk of the energy is dissipated within ten inches, ten or twelve inches. As to whether it would be true that with a cone ten inches in diameter a baffle would be essential, whereas in a cone exceeding that diameter the remainder of the cone, itself, would function in place of the baffle—I would say it would be essential to have a baffle on a cone under ten inches, if an attempt were made to market it on today's market. It would not be so essential to employ a baffle with a cone exceeding ten inches. I know of cones exceeding ten inches where no baffles are used.

Mr. Loftus: I think that is all.

Cross-examination.

By Mr. Davis:

Q. Mr. Danielson, the matter of use of baffles on these cone loudspeakers is a recent development in the art, is it not?

A. Yes, as far as the loudspeakers are concerned.

[fol. 106] Q. That is what you had in mind when you spoke in your testimony as you did, of the market of today; that is, when you said that these things are not salable on the market of today, you mean that because today the market demands an added improvement of a baffle. Is that right?

A. Yes, the market of today requires a greater frequency range of reproduction.

Q. That is, it requires a lower frequency than it used to?

A. Yes.

Q. And lower than the old horns would give?

A. Yes, or the old cone speakers.

Q. By the last part of your answer you mean that they used to make cone speakers that did not give so low a response as the new speakers with the baffle; is that right?

A. That is correct.

Q. When you say "used to," you have reference to manufacture of two or three years ago?

A. Yes.

Q. Do you manufacture cone speakers?

A. No, we do not.

Q. Do you buy them?

A. No, we do not. We do not buy them for retail, if that is what you mean to imply.

Mr. Davis: That is all.

If your Honor please, I have just sent out and bought here in San Francisco a loudspeaker which is marked "Jensen Dynamic Speaker," and if it will be admitted by the other side that this speaker is of the manufacture of the last witness, Jensen, it would save some cross-examination.

[fol. 107] Mr. Loftus: Yes, he said he manufactured speakers. This looks like one of his.

The Court: Have you concluded with this witness?

Mr. Davis: Yes.

Defendant's Exhibit 19.—The patent to W. H. Davis and F. E. Joss, No. 1,389,632, assigned to Lektophone Corporation, the plaintiff in this case, was received in evidence as Defendant's Exhibit 19.

(It was stipulated that this is a patent in which W. H. Davis, counsel for plaintiff, is a coapplicant.)

Rebuttal Testimony on Behalf of Plaintiff

Testimony of Marcus C. Hopkins, for Plaintiff (in Rebuttal)

Marcus C. Hopkins was called as a witness on behalf of plaintiff, was duly sworn and testified as follows:

Direct examination.

By Mr. Davis:

I am the inventor and patentee of the two patents here in suit. As to the circumstances under which I made these inventions—I was engaged in designing and building sound reproducing devices in Newark, New Jersey, and, being very much interested in it, I later went to the point of greatest activity at the moment, which was the Edison laboratories, at West Orange, and there entered the em- [fol. 108] ploy of Mr. Edison, in investigating what you have spoken of as the sound-box and horn combination devices, which he was very anxious to perfect at that time, and produce in a more compact form. My work under Mr. Edison continued for about two years. That time had to do with the investigation of the sound-box and horn combination. The result of the experience I then acquired is correctly summarized in my patent No. 1,271,529, page 1, lines 27 to 66. After that experience with the sound-box and horn combination, I turned to an investigation of direct acting devices, such as sounding boards, which led me to the cone type of structure which forms the subject matter of my patent. As to the sort of sounding board structures I tried out—when I first decided to turn to an investigation of those devices, of course I started with the well-known things in existence at that time, which was a piano sounding board, zither, guitar, and musical instruments which employed the regular sounding board; but we very shortly found that these were not suitable for the purpose, they all had too much inertia, and I began to build lighter sounding boards of my own design, and continued to make them lighter, until I got to make them of paper. I made a considerable number of paper structures, and eventually arrived at the cone type.

As to what experiments I made with the cone type of speaker before I filed my patent application—when I first [fol. 109] began the use of the cone, with the idea that it was a light and very stiff structure, it almost immediately showed a big advance over any of the other structures that we tried. I started a long series of experiments with different sizes, different materials, different angles, and in the

course of that series of experiments it narrowed down to practically one type of cone, and which is the general type given in the patent 1,271,529. The use of the cone was limited by the waving or rattling that invariably accompanied a simple cone, and we tried different angles and different materials, but we never got away from the fact that the edge would break up into nodes, even with the small amount of energy that we had available in those days. When the cone vibrated, the outer edge of the cone would break up into nodes or loops, the nodes being the comparatively still portions which moved with the movement of the cone, but the loops the portions in which one wave was going out while another was going in. In other words, it was a bell motion of the paper of the cones.

The article entitled, "The Vibratophone," in the "Talking Machine News," which is in the binder of prior art patents (Defendant's Exhibit 9), shows a simple cone in the sense in which I have used that expression, that is, a simple free-edge cone of the type we were working with at that time and which shows these edge nodes and loops.

Q. Did you hear these noises, as well as see them?

[fol. 110] A. Yes, they resulted in what then, and had been for some time, known as blasting.

Q. What did you do to overcome that trouble?

A. I began to support the edge of the cone, to prevent vibration, and that problem had to take into consideration that we must allow the cone to move axially to have it play; in other words, we wanted the axial movement without any breaking up of the edge. So we put a flexible edge on the cone, and supported that upon a rigid support.

Q. Now, in your patent, Mr. Hopkins, in patent 1,271,529, at the bottom of the second column of page 2, and the top of the first column on page 3, I find this stated:

"While I prefer to construct the tympanum in the form described and shown with a smooth surface, especially in view of the ease of construction, yet it is possible to form radial or concentric corrugations in the plane peripheral portion 1, and produce a light, stiff, and very satisfactory article for the purpose."

Q. Did your experiments include the forming of the radial and concentric corrugations in the plane peripheral portion?

A. Yes; we tried both radial and concentric, and when radial corrugations were used it stiffened the rim, and when concentric corrugations were used it made the rim more flexible.

Q. What effect did that have upon the operation of the device, as a whole?

A. Well, it permits some control in the use of the ma- [fol. 111] terials that were used, and permitted some variation in the width of the outside rim.

Q. And did this change in the width and flexibility of the rim affect the acoustic operation of the device?

A. No; the structure of the outside rim was intended to produce the required functioning characteristics, but it affected the space that was taken up by the outside rim.

Q. Now, are the functional characteristics of the rim correctly stated in the patent 1,271,527 as follows—I will read from page 3, line 124:

"The plane peripheral portion 1 of the tympanum maintains the place of the conical active portion of the tympanum, and yields sufficiently to permit of the required motion of the conical portion, resisting, however, displacement of the conical portion in just that degree necessary to maintain the form and neutral position of the active conical portion."

A. Yes.

Q. Now, suppose you made the rim too stiff, that is, stiffer than was necessary to be efficient, to effect that purpose, how would that affect the device?

A. That would suppress the activities of the cone, and reduce the efficiency of the structure.

Q. Is there such a thing as making the rim too flexible?

A. Well, theoretically, I would say that it could be made too flexible, but I have never found a case where a practical [fol. 112] rim that was applied to a cone that was yet too flexible.

Q. In your patent No. 1,271,527, in the second line and following, on page 4, you say:

"Were the plane peripheral portion 1 of considerably greater width or markedly narrower than described, its function would be destroyed to a degree corresponding to

the remoteness of the departure from the approximate proportion given, and the effective portion of the conical portion of the tympanum would be proportionately lessened."

What is the meaning of that last sentence?

A. If you made the outside rim too wide, speaking in terms of its being a portion of the tympanum, if you made the rim too wide that would lessen the area of the cone, which is really the important active element.

Q. What would be the effect if you clamped the edge of the cone directly in the clamping ring without an interposed flexible ring?

A. That would suppress the activities of the cone nearly altogether, and it would become very, very inefficient, practically nothing.

Turning to the subject matter of claims 29 and 30 of patent 1,271,527, that is, the lever reduction idea, I will describe its purpose and effect. The object of the lever reduction was to accomplish an efficient connection between the driving element and the cone. We found that, to produce the highest efficiency, it was necessary to reduce the [fol. 113] motion between the driving element and the apex of the cone, and that this was practically true in every condition that we investigated. The sound-box and horn combination, to get the same efficiency, or the best efficiency, was always a step-up leverage.

As to whether I ever built a device exactly like that illustrated in the two patents in suit—that device actually existed and the drawings that are in the patents were made directly from it. It was a machine which actually played and was demonstrated by me.

My interest in the plaintiff corporation is that I am a stockholder and a licensee. I own part of the stock and I got that for my invention. It is somewhere around 17%.

Mr. Davis: That is all.

Cross-examination.

By Mr. Loftus:

Q. In your work in the Edison laboratory, did the Edison Company become interested in your sound regenerator?

A. I did not come in contact with the Edison Company, as I was working personally for Mr. Edison.

Q. Is it not customary, there, when you enter the employ of Mr. Edison, that you have an agreement to assign your inventions to your employer?

A. It was never done at that time, the occasion never arrived.

Q. As a matter of fact, Mr. Edison was not interested in the proposition, at all, was he?

[fol. 114] A. Mr. Edison was not interested in it, apparently.

Q. The reason for that was because you had not obtained any success with your experiments?

A. No, I know that the reason was not that; but I do know what the reason might have been; one reason might have been that Mr. Edison, unfortunately, was very deaf, and while he could hear moderately well if he could get his ear in the focus of the horn, this device did not have a focus, and I often thought that possibly he did not hear what we did.

Q. Just why did you leave Mr. Edison's employ?

A. I went back to the law business just about that time.

Q. You are a lawyer, are you?

A. I am a patent attorney.

Q. You took this alleged invention of yours, then to Mr. Davis' firm, did you?

A. No. I went to Mr. Edison and I stated I thought that this deserved attention, and I said, "May I try to do it?" And he handed everything to me and said to go to it. Sometime later, after considerable more development work has been done, I went to Mr. John C. Pennie, who was the senior member of what is now Mr. Davis' firm, and he and I became interested in it.

Q. You and Mr. Davis' firm organized this Lektophone Corporation, did you not?

A. I would not say that I was personally engaged in the organization of that particular corporation.

[fol. 115] Q. Then the firm of Mr. Pennie organized it: That is true, is it not?

A. That is true.

Q. And the Lektophone Corporation never did any actual manufacture, either of phonographs or loudspakers, did it?

A. No, I think it confined its efforts to experiments.

Q. How many structures did you build, yourself, under these patents?

A. You mean experimental models?

Q. Experimental and otherwise.

A. I never counted them, but I made several dozen, I should say.

Q. When did you first build a loudspeaker with a conical diaphragm?

A. When did I personally engage in the building of them?

Q. Yes.

A. I think it was the year after the armistice.

Q. You built one, or did you engage in it then commercially?

A. I have never engaged in it commercially, until very recently, but I maintain a laboratory in Washington, where experimental work is done.

Q. In working on this problem, you had no thought of any loudspeaker sound reproduction such as these models represent here, did you?

A. I was not sufficient of a prophet to foresee the condition that has arisen with the advent of radio broadcasting, but——

Q. You were——

[fol. 116] The Court: One minute. Let him finish.

A. But we always kept in mind any use that the invention that we were working on might be applied to.

Mr. Loftus:

Q. But at that time you were directing your attention to phonographs, only: Isn't that correct?

A. To mechanical reproduction of sound.

Q. What is the essential thing to the success of a loudspeaker? It is the operating unit, is it not?

A. I do not think any one thing is the essential thing.

Q. It is more important than the cone, is it not?

A. I would not say so.

Q. Don't you agree with me that with a proper operating unit you can reproduce these self-sustaining sound waves, with any kind of a cone?

A. No, I would not agree with you.

Q. What do you think that cone requires?

A. Why, it requires design and building to attain a flat amplitude curve, and a high degree of efficiency, and a wide range of frequency.

Q. There are many free-edge cones on the market that are considered fairly successful, are there not?

A. I never considered any of them successful.

Q. They do exist, and they are sold in large quantities: That is true, is it not?

A. I have not seen very many free-edged cones.

Q. The largest seller, perhaps, is this Western Electric type, isn't that true?

A. I would not say so. There are quite a number of [fol. 117] them that have been manufactured. I am not acquainted with the figures on these things.

Q. Now, this peripheral rim portion which you now call the flexible rim, that is the same rim that you testified in the Western Electric suit was of springy material, is it not?

A. It should have some springy action.

Q. Why is that?

A. That is due to the condition that requires the attainment of very high efficiency. When this combination of three elements was made, the amount of energy which we had available was very small, compared with what is used ordinarily today, and the degree of efficiency was the best that had been attained with a horn and sound-box combination, which had been worked on for thirty or forty years; it was necessary to have the cone respond to a very small signal, and in a very sensitive way, and that degree of efficiency is best attained by having a slight springy action in the rim. If the power that is available in the signal is sufficient, the requirement for having any of that spring action falls off, and when the power is excessive, the less you have of it the better.

Q. Now, you also refer to that peripheral rim in your patent as a supporting rim. By that you mean that it must be sufficiently stiff and rigid to support the cone in vertical position?

A. Do you mean with the axis in vertical position, or standing with its base in a vertical plane?

[fol. 118] Q. The axis vertically disposed, as you had it in this phonograph.

A. No—it is not necessry that it be placed in that condition, but it should be supported in the center of the aperture in which it is mounted.

Q. Where you speak, here, of this peripheral rim serving to return, to restore the cone to neutral position, you refer to the neutral position axially, do you not?

A. In a way, yes. That is, the driving element need not be required to carry any of the weight of the cone but the movement of the cone can be effected either side of the neutral position, or where it would substantially hang in the support of the rim.

Q. What do you mean here in your patent where you speak of "the tympanum being of sufficient area to impart to the surrounding free air, when vibrated, sound waves substantially corresponding in intensity to the original sound waves"?

A. We meant there the sort of reproduction which was then being attained with phonograph of the sound-box and horn type, which were able to make the speech voice or singing voice equal in intensity to the natural voice.

Q. That expression does not mean much to-day, as applied to loudspeakers, does it?

A. No, for a number of loudspeakers to-day are caused to work at intensities far above anything that would be considered normal.

Q. Almost any size of cone to-day will produce the self-[fol. 119] sustaining sound waves, won't it, if you got enough power in the operating unit?

A. It will produce some of the frequencies, I do not believe that many of them will produce an amplitude balance and response which we would call a real good quality.

Q. You heard us operate this device, Exhibit 13, didn't you, built after the manner of the Dann & Lapp patent?

A. Yes.

Q. Wherein the cone has a four-inch dimeter—you heard that operated?

A. Yes.

Q. Did it reproduce self-sustaining sound waves?

A. Undoubtedly there were quite a lot of them there.

Q. Was that in free air without a horn?

A. I am not sure that it was in free air.

Q. Why not? You saw us remove the horn?

A. Well, I would say that was a glorified sound-box, but I would not say that that diaphragm was a cone operating in free air.

Q. The cone is exposed on both sides, is it not?

A. There is a depression in a metallic diaphragm there—the portion that has the depression in it is exposed.

Q. That is the only part that gives off any sound, isn't it?

A. I would not say so.

Q. Where else was the sound given off?

A. I have not had any opportunity to investigate that particular type of thing, but I would say that the metal plane just adjacent to the cone is doing something.

[fol. 120] Q. I notice the dampers on here are felt, on the flat portion.

A. Yes, I notice those.

Q. What would be the purpose of putting them on there?

A. I have not the slightest idea.

Q. The effect, however, would be to dampen any sound coming through them, would it not?

A. I imagine that it was, because the diaphragm is tin, or metal.

Mr. Loftus: That is all.

Mr. Davis: That is all.

Testimony of Clair L. Farrand, for Plaintiff (in rebuttal)

Clair L. Farrand was called as a witness on behalf of plaintiff, was duly sworn and testified as follows:

Direct examination.

By Mr. Davis:

I am the president of the Farrand Manufacturing Company. That company is a licensee and manufactures radio loudspeakers under the patents here in suit. I am also a director of the Lektophone Corporation and I own some stock in that corporation. I am the Farrand who manufactured the so-called Phonetron. The Phonetron was a

loudspeaker using a conical diaphragm of the type used in the phonograph called the Actuelle, manufactured by the Pathe Phonograph Company. It was actuated by an electric motor or driver of the moving coil type.

[fol. 121] Q. This device, which I show you on page 2 of this book, is this a picture of the Phonetron?

A. Yes.

Q. Is the photograph on page 1 of that book a photograph of the Actuelle Phonograph that you spoke about?

A. Yes, it is.

The circumstances under which I began the manufacture of the Phonetron were as follows:

I was interested in developing a wireless telephone system which requires a loudspeaker. I heard of the development and manufacture of the phonograph called the Actuelle, by the Pathe Phonograph Company, and sought to use that as a loudspeaker. I tried other types of diaphragms, and pleated paper diaphragms. The use of a diaphragm without a horn particularly appealed to me, because loudspeakers had what were called "horny" sounds, and reverberations that were objectionable, and I thought that the cone diaphragm, working directly on the air, without the use of the horn, would probably give more faithful reproduction. As to whether there had been any improvement in the art of telephony and the radio art which made it possible to get a superior form of energy over what was possible in the phonographic art—at that time the vacuum tube amplifier had been developed to the extent that it was possible to get voice currents,-that is, currents corresponding in frequency to voice and music, in practically unlimited quantity, and microphones had been developed so that these currents corresponded very exactly to the orig-
[fol. 122] inal sound. The principal difficulty in reproducing music or voice seemed to lie with the speaker, and it was to this particular thing that I directed my attention.

The loudspeakers that were on the market at that time were sound-box and horn loudspeakers. The Phonetron was manufactured after several years of development in 1921 and was sold in that year.

As to whether my company was the first licensee to manufacture radio loudspeakers under the patent as distinguished from phonographs, my company was not formed

then; I personally was the first one to do so. Subsequently, my company after formation, took over that manufacture.

The next company that manufactured a loudspeaker under license was the Pathe Phonograph and Radio Corporation. That was a company that was the outgrowth and successor to the Pathe-Freres Phonograph Company, that manufactured the Actuelle phonograph. When I got my license to manufacture the Phonetron, I was not then an officer of the Lektophone Corporation.

As to what I found with respect to the possibility of getting a license for a radio loudspeaker—I found that the Pathe Phonograph Company had an exclusive license, and I found that there were indications that I could get a license to manufacture the product if I conducted negotiations with the Lektophone Corporation and were given a license limited to the radio field.

The photographs on the third and fourth pages of the [fol. 123] book shown to me are photographs of the products of the Pathe Phonograph & Radio Corporation. The first one is the first radio loudspeaker type and the second one is a phonograph. The photograph on the fifth page of the book is a photograph of a loudspeaker device we manufacture, that, is the Farrand Manufacturing Company, commencing in 1925.

The next licensee was the American Bosch Magneto Corporation, who took a license in August, 1925, and the photographs on pages 6 and 7 of this book are the product of that company. There are two forms.

The photograph on page 8 is a later form manufactured by the Pathe Phonograph & Radio Corporation. The next licensee was J. S. Timmons, Inc.——

Mr. Loftus: I object to this line of examination. These licenses are apparently in writing, and they should be produced.

The Court: What is the object of it?

Mr. Davis: The object is to show the wide acquiescence and payment of royalties. The licenses are available if counsel cares to look at them.

The Court: Very well, proceed.

The next license was to J. S. Timmons, Inc., who took a license in the fall of 1925. The photograph on page 9 in this book, is a photograph of the Timmons product.

The photograph on page 10 is a photograph of the product of the Radio Foundation, Inc. This company was a li-
[fol. 124] censee who took a license in April, 1923, and who sub-licensed to the Pathe Phonograph & Radio Corporation. The next licensee was the Stromberg-Carlson Telephone Manufacturing Co. They took their license in December, 1925. The photograph on page 11 of this book is a photograph of their product. The next licensee was the Radio Corporation of America, who took their license February 15, 1926. They paid $200,000 as commuted royalties. The photograph on page 12 of this book is a photograph of one of the products of the Radio Corporation of America.

Q. I have here a radio loudspeaker. Can you identify that?

A. That is a radio loudspeaker made by the Radio Corporation of America, known as Model 100-A.

Q. Is that a recent model?

A. Yes, it has been on the market about a year and a half.

Q. Will you tell us whether the cone and the supporting rim in the device are all made in one piece?

A. They are all made of one piece of paper.

Q. Do you know whether that device is marketed widely, or not?

A. Yes; I believe the Radio Corporation sold 500,000 of that type.

Q. Do you know whether it reproduces sound over a wide range without blasting?

[fol. 125] A. It is one of the best speakers in the market in that regard.

Mr. Davis: I offer this Radio Corporation speaker in evidence as Plaintiff's Exhibit 20.

Mr. Loftus: Objected to as immaterial, irrelevant, and incompetent. There is no evidence presented here of a competent nature to show that this has anything to do with the Hopkins patent.

The Court: It will be received over the objections; if not competent nor material, the Court will ignore it in making up its decision. An exception will be noted for counsel.

Plaintiff's Exhibit 20: The Radio Corporation loudspeaker was received in evidence as Plaintiff's Exhibit 20.

Mr. Davis: I will call your Honor's attention to the fact that there can be found on the device the patent marks, which refer to the patent here in suit.

Mr. Loftus: Is there any patent marking on this model?

Mr. Davis: Yes.

The Witness: The bottom of the box has been taken off.

Mr. Loftus: The patent marking is not on that.

Mr. Davis: It is on the part that has been taken off.

The next photograph of this book on page 13, is a photograph of a Titanafram made by the Titanafram Corpora-
[fol. 126] tion which took a license in 1927. That license has since been acquired by the Brandes Company, who make the Kolster-Brandes speaker. On page 14 there is another photograph of a speaker made by the Farrand Manufacturing Company. It is called the Sandar Senior Speaker. On page 15 there is a photograph of a similar speaker of the same name, Sandar Junior. On page 16 is a photograph of the Radio Corporation of America, Model 100-A, such as the one just put in evidence. On page 17 is a photograph of another form of the Timmons speaker. On page 18 is a photograph of another form of the Farrand Manufacturing Company's speaker. That was a new model a year ago. On page 19, there is a photograph of a new model of the Stromberg-Carlson Telephone Manufacturing Company speaker. On page 20 there is a photograph of a speaker made by the Amplion Corporation of America who took a license in 1927. They are an American subsidiary of an English corporation, I believe. On page 21, there is a photograph of the Brandes Products Corporation speaker. This one of the devices that were involved in the suit in the Third Circuit of Lektophone v. Brandes. On page 22 is a photograph of the O'Neil Radio Corporation's speaker. That Company succeeded to the Thompson license which they acquired on November 1, 1927. On page 23, is a photograph of the Utah Radio Products Company loudspeaker. They are a corporation manufacturing in the middle west
[fol. 127] and took their license on November 1, 1927. On page 24 is a photograph of the United Radio Corporation loudspeaker. They are the makers of the Peerless speaker and recently took a license on April 27, 1928.

Except for the Radio Corporation of America, and up to the date of this Peerless license, all the licenses were

granted on a royalty basis. The Peerless license was on a commuted royalty basis, practically the same as the Radio Corporation of America.

The photograph on pages 24, 24a, 24b, and 24c, are photographs of the Peerless product in different positions. This one is with the cover removed.

Q. Now, as I understand it, in the Peerless license there was a distinction made between the Hopkins patent here in suit, and a certain pending patent application of Farrand, that was filed under your name as inventor. Will you tell us about that?

A. The Peerless license provided that they would pay $160,000 for the patents and applications of the Lektophone Corporation, other than those in the name of Clair L. Farrand; upon the payment of an additional $50,000 they had the option of securing a license under those applications.

Q. Can you tell us approximately how many loudspeakers have been manufactured and sold under these licenses that you have testified about?

A. There have been approximately 1,250,000 licensed speakers sold.

[fol. 128] Cross-examination.

By Mr. Loftus:

Q. How did you arrive at this number of loudspeakers that you mentioned in your last answer as having been sold under the Hopkins patent?

A. I have some notes which I have taken from the Lektophone Corporation books on the number of speakers—I have some notes of the number of licensed speakers sold, which I have taken from the books of the Lektophone Corporation, and they total approximately 675,000 speakers, which, when added to the 500,000 speakers that the Radio Corporation reported to have made——

Q. (Interrupting.) Reported to whom?

A. In their financial report they made of loudspeaker sales.

Q. In other words, you read that in the newspapers, did you?

A. I read it in a report of the Radio Corporation.

Q. Personally, you have no knowledge of whether they sold 500,000 or 50,000?

A. That is correct, it is an estimated figure. Do you wish me to continue with my answer?

Q. Yes.

A. 75,000 speakers made by Brandes prior to the time they acquired their license, making a total of 1,250,000 speakers.

Q. Now, have you any figures showing the number of speakers that were made by your licen*ses* and reported to you since the time they obtained their license?

[fol. 129] A. Yes, they total approximately 675,000 speakers.

Q. That is all that you have any record of; the rest is practically guesswork?

A. No, we have a record of the Brandes Company, which is approximately 75,000 speakers.

Q. Made at a time when they were not a licensee?

A. That is correct. That makes a total of 750,000.

Q. Now, most of these licensees were driven to take this license by your bringing suits against them, were they not?

A. I do not believe so.

Q. How many suits have you brought under these Hopkins patents?

A. There are thirteen licensees, and I believe that suits were filed against only two or three, I am not sure about the third.

Q. I am asking you how many suits, in all, have you commenced under these Hopkins patents?

A. I don't know the number; there are quite a few suits against concerns that are not licensees.

Q. Probably 50, in all, aren't there?

A. Probably 20—at least 20, I would say.

Q. Aren't there more than that? I think I have a record here of 30.

A. I think 30 would be about correct.

Q. May I ask you again, how many of your present licensees were formerly defendants?

A. I believe two or three.

Q. Will you name them?

A. The United Radio Corporation, O'Neill Radio Corporation, Kolster-Brandes, and possibly—no, that is all; three.

[fol. 130] Q. Now, in these license agreements, there are several patents and pending applications enumerated in them, are there not?

A. Yes.

Q. And those patents, in addition to the patents in suit, include these different patents taken out by Mr. Davis jointly with Mr. Joss.

A. What patent are you referring to?

Q. Schedule A attached to the Radio Foundation license. To save time, I will ask that this entire list of Schedule A be copied into the record at this point. It includes some ten or twelve patents, in all.

(Schedule A is as follows:)

"SCHEDULE A

"Marcus C. Hopkins

U. S. Pat. #1,281,527, dated July 2, 1918, for 'Sound Regenerating machine.'

U. S. Pat. #1,271,528, dated July 2, 1918, for 'Sound Regenerating Machine.'

U. S. Pat. #1,271,529, dated July 2, 1918, for 'Acoustic Device.'

"Wm. H. Davis and Frederick E. Joss

U. S. Pat. #1,312,957, dated Aug. 12, 1919, for 'Phonograph Transmission Rod.'

U. S. Pat. #1,312,958, dated Aug. 12, 1919, for 'Phonograph Transmission.'

U. S. Pat. #1,312,959, dated Aug. 12, 1919, for 'Talking Machines.'

U. S. Pat. #1,316,536, dated Sept. 16, 1919, for 'Tone Control Device for Talking Machines.'

[fol. 131] U. S. Pat. #1,316,537, dated Sept. 16, 1919, for 'Tone Control Device for Talking Machines.'

U. S. Pat. #1,389,632, dated Sept. 6, 1921, for 'Acoustic Diaphragms.'

"Frederick E. Joss

U. S. Pat. #1,318,083, dated Oct. 7, 1919, for 'Talking Machine.'

U. S. Pat. #1,359,995, dated Oct. 27, 1920, for 'Stylus Holders for Talking Machines.'

Application of Clair L. Farrand for U. S. letters patent, Serial Number 464,009, filed April 23, 1921."

Q. I notice, also, that the license agreement includes on the application of Clair L. Farrand, Serial No. 464,009, April 23, 1921. Tell us about that application. Is that one which is supposed to mature into a patent on the broad idea of an electrical unit and a cone diaphragm?

A. Yes.

Q. Which would be a great deal more important than the Hopkins patent if issued?

A. I could not say.

Q. At the time the Radio Corporation of America took this license that you referred to, they were building a large cone, weren't they, something like thirteen inches in diameter?

A. They were building two cone speakers, one was the Model 100-A—I believe the cone in that speaker was about nine inches in diameter—and another model called the Radiola 104, that had a cone about six and a half inches in diameter.

[fol. 132] Q. Isn't it true that the Radiola 104 6½-inch diameter cone appeared on the market after this license was negotiated from the Lektophone Corporation?

A. My impression is it was on the market before.

Q. And likewise, with this last-named licensee, United Radio Corporation, it is true that they are bringing out a large diameter cone, isn't it, something in excess of twelve inches?

A. I have not heard of it. The only speaker I know of that they are building is a speaker with a cone of about seven inches in diameter.

Q. You had nothing to do with the negotiations leading up to this license granted by Lektophone Corporation to the United Radio Corporation?

A. No.

Q. So you don't know what devices it applies to, do you?

A. Yes, I do; the license gives them the right to use and build loudspeakers under the Hopkins patent.

Q. A cone how large in diameter?

A. Either large or small; there is no restriction in that regard.

Mr. Loftus: That is all.

Plaintiff's Exhibit 21.—The book of photographs identified by the witness Farrand on direct examination was received in evidence as Plaintiff's Exhibit 21.

[fol. 133] Plaintiff's Exhibit 22, for identification.—The book of licenses was marked for identification as Plaintiff's Exhibit 22.

Testimony of H. J. Hasbrouck, for Plaintiff (in Rebuttal)

H. J. Hasbrouck was called as a witness on behalf of plaintiff, was duly sworn and testified as follows:

Direct examination.

By Mr. Davis:

I have been attending here in court during this trial. You asked me this afternoon to go out and buy for you a radio loudspeaker of the Jensen Manufacturing Company, and I did so. The speaker you have in your hand is the one I bought. I bought the speaker just as it is.

Q. Were you offered any baffle-board or cabinet connected with it?

Mr. Loftus: That is objected to as immaterial, irrelevant and incompetent. The device has nothing to do with the defendant in this case.

The Court: It would so appear, but for the sake of the record he may answer; if not material, the Court will ignore it in making up its decision. Counsel may have an exception.

A. The salesman asked me if I would like a cabinet for it, and I told him no, I wanted it as it was displayed in the window.

Q. It was so displayed in the window?

A. Yes.

Q. Where did you buy it?

[fol. 134] A. At the Coast Radio Company, 1106 Market Street.

Plaintiff's Exhibit 23.—The loudspeaker made by the Jensen Manufacturing Company identified by the witness is received in evidence as Plaintiff's Exhibit 23.

Mr. Davis: That is all.
Mr. Loftus: No cross-examination.

Testimony of Louis A. Hazeltine, for Plaintiff (Recalled in Rebuttal)

Louis A. Hazeltine was recalled as a witness on behalf of paintiff, and having been previousy duly sworn, testified as follows:

Q. Mr. Hazeltine, you heard yesterday the oral demonstration of defendant's Exhibit 17, in which loud, rattling noises were produced, did you?
A. I did.
Q. What caused those noises?
A. I heard them. I do not think that they were due to the blasting caused by the wave action which I described yesterday. I checked up that conclusion first by examining the structure, and then by testing it again, and I found out that the loud and very disagreeable noise was due to the striking of the pole pieces in the driving motor. The driving motor was not suited to that cone, and to the amount of power that might be readily applied to it.
Q. Will you please point out to the Court where the pole [fol. 135] pieces are, and where the striking occurred on Exhibit 17?
A. The pole pieces may be seen midway between the poles of the large permanent magnet. The pole pieces that I refer to are made of laminated iron, that is, iron sheets clamped together and they show as black members clamped together by light-colored metal. In between these pole pieces is the armature, which is pivoted in the center at the sides. That armature moves back and forth between these pole pieces and the clearance, as can be seen, is very small, a few thousandths of an inch. And when current is passed through the coil of this motor element in order to vibrate it and produce sound, that armature oscillates back and forth about its pivot, and when the power is as great as was used in the court yesterday, the armature travels over the whole space available for its motion, and strikes, here, against the pole faces, causing a series of sharp raps, which cause that very disagreeable noise that we heard.

Q. Is that noise due to any fault or deficiency of the cone structure, or not?

A. No, that is quite independent of the cone structure. It means that the motor element is not properly adapted to that particular cone. That is a problem that is present always whenever we have a motor element of this moving armature type. It is a thing that always has to be considered and taken care of by the designer of a loudspeaker system.

Q. Was that rattling effect apparent in one of the other [fol. 136] exhibits that was illustrated here yesterday, due to the same lack of balance in design?

A. Yes, that was present in the Lumiere loudspeaker, as was stated by Mr. Tenny in his testimony, and the reason for its occurrence here is precisely the same as he said to be the cause with the Lumiere, an improper adaption of the motor driving element to the loudspeaker system.

Q. Then the rattling that we heard was not due to the fact that the rim of Exhibit 17 was made of paper, and the absence of that noise was not due in Defendant's Exhibit 15 to the fact that the rim was made of leather, instead of paper?

A. I believe that there is no difference in that respect. I have made further tests to determine that last night, and found out that the Radiola 100-A, which I believe is Exhibit 20, which has a paper rim, behaved substantially the same way as one of the Rola speakers which had a leather rim. I tested them first as they were, that is, each one having felt in the back of the cone, and without the presence of any baffle, the two being of similar dimensions, and, therefore, affording a direct comparison. I found out that with the ordinary power it was not possible to cause a striking of the pole pieces in either case; nor was there any conspicuous blasting due to any paper effect. I then removed the felt from the back of each of these loudspeakers, and found that in both cases the removing of that damping [fol. 137] means caused an increased amplitude, and I found that was sufficient in both cases to cause striking of the pole pieces.

Q. As I understand it, that comparison was made between this device Exhibit 20 and a Rola loudspeaker which is like Exhibit 15?

The Court: Was the other side represented at these tests?
Mr. Davis: No.

A. Yes, like Exhibit 15, first with the felt in place, and then with the felt removed.

Q. It was testified that a great part of the energy is absorbed in the leather ring of defendant's loudspeaker. Do you agree with that?

A. No. I believe that it can be shown that that is not the case, because there is present a pronounced resonance effect, that is, the loudness of the sound, when the striking of the pole pieces does not occur, is much more pronounced at a certain frequency than at other frequencies. If there was any absorption of energy in the rim, then that would not take place, the resonance would not be so pronounced. The conclusion is that the amount of energy absorbed in the rim is but a small part of the total energy under ordinary conditions.

Q. Will you compare that with the amount of energy absorbed in the paper rim of Exhibit 20?

A. In both cases, the amount of energy absorbed in the rim is relatively small.

Q. Will you say whether or not the substitution of leather for paper changes in your opinion, the principle or mode [fol. 138] of operation of Defendant's devices, consisting of the paper cone, rigid frame, and interposed flexible rim?

A. No, it does not.

Q. Now, you have testified that the loud rattling noises we heard yesterday were not due to the weaving and consequent blasting of the rim about which you testified yesterday. Will you please illustrate for us that weaving and blasting about which you testified yesterday?

A. A Rola speaker has been prepared in which the leather rim has been removed. I believe this is not an exhibit. I tested that and found that it shows the weaving effect very well.

Mr. Davis: If your Honor please, I want to have a physical demonstration of this for a moment.

The Court: Very well, proceed with it.

Mr. Loftus: This is not the defendant's structure at all, your Honor.

The Court: I will allow it to be introduced over the objection; if not competent or material the Court will ignore it in its decision, and counsel may have an exception.

Mr. Davis: While they are preparing that, perhaps I can go ahead with the examination.

The Court: All right.

Q. Mr. Hazeltine, leaving that matter of the demonstration until the assistants prepare the devices, will you please tell us whether or not, in your opinion, the addition of a baffle to defendant's cone loudspeaker changes the principle or mode of operation of the combination?

[fol. 139] A. No, it does not. The addition of a baffle is a useful supplementary means, but does not change the principle of operation.

Q. Directing your attention for a moment to the patent to Dann and Lapp, No. 338,660, and the specifications of that patent, which makes the following statement, beginning line 24 of page 1: "In the accompanying drawings, Figure 1 is a perspective view of our invention applied to the door of a transmitter-box"—What is the transmitter-box?

A. I understand that this, which is shown in Figures 1 and 2 particularly of the patent, represent the door that used to be used in ordinary house telephones, that usage being current up to about twenty years ago. The hinges are quite plain, and indicate something as to the size of such boxes, as I should think, perhaps six inches by ten inches in dimensions. The mouthpiece, as shown in this particular one, is turned out of the same piece of wood as the hinged door is made from, as indicated by the sectioning in the drawing, and that mouthpiece, of course, is of the dimensions, approximately, of a person's mouth.

Q. Now, could that device, that is, the electrical and mechanical elements attached to the transmitter of that patent, operate in a reverse way, that is, as a receiver?

A. No, not at all. This transmitter is the same in principle, fundamentally, as the ordinary, present-day telephone transmitter; that is not a reversible device; it acts to pro-

[fol. 140] duce changes in electric current when sound waves are impressed, but it cannot produce sound waves due to any change in the electric current.

Q. Will you proceed with this demonstration.

A. I have been operating the Rola speaker with the leather rim removed, and it could be noticed that with certain of the louder notes, particularly those of lower pitch, that there was a disagreeable noise; that is the noise known as blasting, and was due to a fluttering effect, known also as weaving, at the rim of the cone. The rim of the cone, as I explained yesterday, and as is very obvious, is very easily moved, whereas the cone, as a whole, is moved bodily with much greater difficulty; comparatively small motion of the cone at the apex will set up this fluttering effect at certain frequencies, and that fluttering is very pronounced, so that if it is maintained it can readily be seen by the eye, as well as be detected by the blasting effect one hears. I will now operate this——

The Court: Is the rim free there?

A. The rim is free.

Mr. Davis: How is that fluttering prevented in the defendant's device as it is marketed?

A. That is prevented by the interposition of the leather rim between the edge of the cone and the metal frame. Perhaps I had better show that before going to the single frequency. I have here one of the Rola speakers, which is Exhibit 15, and that did not show that blasting effect. Now, to verify that, I will go over to the one having the leather [fol. 141] rim removed. Now, I will come right back to the other one. The smoothness of the sound in the latter case, and the presence of the blasting in the former case seems very evident.

Q. Will you try that on a single frequency?

Mr. Loftus: Your Honor, I do not see where this is material, at all. They are testing out something that is a mutilated form of the defendant's device with the felt removed.

The Court: You may proceed. In all of these patent cases I have noted that wherever one side brings in a lot of curiosities, the other side has an equal amount, too.

A. I have determined that the removing of the felt in the back has not a pronounced effect on the blasting. Having tested this particular speaker with the rim in place, and with it removed, and with the felt removed in both cases, so that the comparison was on the same basis. I think your Honor can see around the edge a haziness showing the pro-

nounced vibration of that rim at the same time that we hear this very disagreeable sound; at certain places around that rim there was a considerable motion, in some places apparently exceeding one-eighth of an inch; then at certain other places there was comparative rest. These other places are known as the nodes. The number of nodes which occur depends on the frequency. It is also noticed in this demonstration that this blasting effect occurred at a certain frequency, not all frequencies, so that when music is [fol. 142] being played, it is a matter of some seconds, or even some minutes, before any blasting comes, and then it comes on very suddenly and disagreeably.

Q. That effect is prevented in defendant's device Exhibit 15 by the leather ring, is it not?

A. By the leather ring.

Q. You needn't demonstrate that.

A. In that case the result is a steady, pleasing musical note in place of the rasping due to the weaving or blasting effect.

Mr. Davis: I offer in evidence the Rola speaker with the leather detached from the edge of the cone, about which the witness has testified, as Plaintiff's Exhibit 24.

Plaintiff's Exhibit 24.—The Rola speaker so offered was received in evidence as Plaintiff's Exhibit 24.

Cross-examination.

By Mr. Loftus:

Q. Professor, the electrical unit which is attached to this Exhibit 17 is exactly the same as is employed in the standard Rola construction, as shown, for example, in Exhibit 15, is it not, that is, with the same spacing of the pole pieces?

A. I have not examined that carefully.

Mr. Davis: If counsel says that is so, counsel for the plaintiff is willing to admit it. I do not think Mr. Hazeltine has had any opportunity to examine these speakers in detail.

Mr. Loftus: That is the fact, the electrical unit on both of these models is identically alike.

[fol. 143] The Court: That is subject to your examination, of course, at any time, if the witness desires.

(Mr. Loftus:)

Q. Now, in the test that you heard yesterday of Defendant's Exhibit 17, you noticed a blasting at two different frequencies, did you?

A. I did not see exactly what was going on. I heard what was going on. My recollection agrees with your statement, however.

Q. And that blasting at two different frequencies could not be attributed entirely to the spacing of the pole pieces, could it?

A. I believe, as my own test indicated, that there were, as you say, two frequencies at which a loud noise occurred. At one of those frequencies, where the noise was the loudest, that was due to the striking of the pole pieces. At the other frequency, where it was less loud, and required a very large amount of power to produce, that effect, in my own test, and I presume in yours, was due to the fluttering effect of the paper.

Q. Now, you stated that the Dann and Lapp transmitter would not function as a receiver. You do recognize, however, the reversibility of transmitters and receivers, generally, in the telephone art, do you not?

A. No, not generally. Certain devices are reversible, and certain devices are not reversible.

Q. But in general, the principle of a receiver is simply that of a transmitter in reverse, is it not?

A. Not in general at all.

[fol. 144] Q. Would you say that Mr. Tenny's statement that the relationship is about that of a generator to a motor is probably correct?

A. It is correct for some types; quite incorrect for other types.

Q. Now, in regard to the baffles, I will read you a statement in the Radio Broadcast of May, 1928, and ask you if you agree with that—this refers to the Jensen loudspeaker, which was brought in here yesterday in incomplete form. Plaintiff's Exhibit 23. This statement says: "The Jensen

is made in California, and is now generally available, we understand. We have seen curves above reproach, which show the Jensen to have a quite flat response curve from about 60 to 6,000 cycles. With a large baffle-board such as obtained by inserting the loudspeaker in the walls of a home, the lower limit of response can be pushed down to about 35 cycles. A 6-foot baffle-board about 1½ inch thick is, however, very satisfactory." Do you agree with that statement in reference to the use of baffles in connection with loudspeakers of this type?

A. I am not able, of my own knowledge, to check those figures. They do not seem unreasonable to me.

Q. Now, you spoke about the size of this Dann and Lapp structure. Have you ever had occasion to examine any of the early telephone apparatus which can be seen in the various museums, such as the Smithsonian, or Harvard University?

[fol. 145] A. I have seen such exhibits; I have not handled the pieces of apparatus in such exhibits.

Q. Did you note that the mouthpieces in these earlier transmitters were large enough to insert your head in?

A. I did not.

Q. You never have observed that?

A. I saw a great many, but I do not remember any large ones like that.

Q. You do recognize the fact that the early mouthpieces were much larger than the modern transmitter mouthpiece, do you not?

A. *That not* been my recollection. I have seen the exhibit in the Western Electric Museum, which I presume is one of the best, from the labels on the piece of apparatus, and my recollection is that there was not any conspicuous difference in size between the earlier mouthpiece and later ones.

Q. You could see good reason, however, why the mouthpiece in the earlier days should be much larger than they would be at the present time?

A. I think people's mouths are the same size in these days, and I do not see any reason.

Q. The question of sensitivity of the apparatus.

A. It is always, of course, considered good practice to speak up close to a mouthpiece, and if the mouthpiece is too large it would seem to me that that would be detrimental.

Q. What is your opinion as to the factor which has brought about the extensive use of these cone type loud-
[fol. 146] speakers. It is the cone, itself, it is the vacuum tube, is it not, that has made this possible?

A. The vacuum tube has made radio broadcasting possible, that is, it is one of the elements which has made it possible. I would not, however, agree with you, because I have no reason to believe that with a continuation of the phonograph industry the cones might not have gone into considerable use.

Q. Without the vacuum tube used to amplify the electrical energy, you could not have operated any of these cones, could you?

A. I do not think you could very readily have operated them as loudly as you did, but they could have been operated.

Q. That apparatus there includes a vacuum tube, does it not?

A. I suppose so.

Q. And the function of those vacuum tubes is to amplify that electrical energy?

A. Yes.

Q. So that with a weak impulse that you get at the pick-up device, using that amplifying apparatus, you can actually, in any kind of cone, give off self-sustaining sound waves, can you not?

A. You can give off self-sustaining sound waves from a cone of sufficient size, or from any cone at sufficiently high frequency.

Q. You can give off self-sustaining sound waves from that little sound-box that Mr. Davis had in his hand here the other day, could you not?

A. At sufficiently high frequency, but not at most of the useful frequencies.

Q. Don't you think we could hook this up to that appa-
[fol. 147] ratus over there and it would be heard throughout the courtroom?

A. It would be heard very weakly, except at high frequency, unless a very large amount of power was applied to it.

Q. You could apply that large amount of power with this amplifying apparatus, could you not?

A. Of course, I have not tried what you have suggested, but my belief is that you would not get any large sound except at high frequency.

Q. What is your idea of a self-sustaining sound wave?

A. My idea of a self-sustaining sound wave, as the expression is used in the Hopkins patent, is a wave which is of a considerable amplitude, and which uses the greater part of the vibration of the air in the immediate neighborhood of the diaphragm.

Q. He also states that a self-sustaining sound wave was one of approximately the same intensity as the original sound wave impressed upon the record, did he not?

A. I don't remember that.

Q. Assuming that that does appear in the patent, with proper amplifying apparatus, such as we have here, and increasing it, if necessary, we could take any sized cone and produce a sound wave approximating the intensity of the sound waves which were originally impressed upon that record, could we not?

A. I think that your statement of facts is correct, but I do not see any connection between that and the self-sus- [fol. 148] taining sound wave that you refer to in your question.

Q. But the amplifying apparatus, including these vacuum tubes, would enable you to reproduce self-sustaining sound waves approximating the intensity of the original sound waves impressed upon the record, even though you used a very small cone, would it not?

A. No, not necessarily; before you reached the intensity of the output you might have a striking of the pole pieces, as I explained this morning.

Q. You heard this test of the Dann and Lapp structure yesterday, with a four-inch cone, and that certainly gave off self-sustaining sound waves, did it not?

A. I think it did.

Q. You could make the same demonstration with a three-inch cone, could you not?

A. There is going to be some limit. I do not think that that one would give a wave which could be properly described as self-sustaining at very low frequency; the smaller the diaphragm, the smaller will be the range of frequency at which a self-sustaining sound wave can be produced.

Q. That is quite true, Professor, and you can improve that situation by putting a baffle around the cone, can't you?

A. You could improve it, but you could not correct it; the baffle does not take the place of a large cone. It corrects a different kind of difficulty.

Q. You do agree with me that the baffle applied to a [fol. 149] small cone brings out these low frequency notes to much greater advantage, do you not?

A. Yes, it does, but there are two different reasons for a weakening of these low-frequency notes; a large diaphragm corrects one, and a baffle corrects the other. Neither one corrects both.

Mr. Loftus: That is all.

Redirect examination.

By Mr. Davis:

Q. Counsel, on cross-examination, quoted an article referring to this Jensen cone type loud speaker Exhibit 23, as giving frequency of 60 cycles without a baffle. Will you tell us how that compares with the frequencies that were obtainable with the ordinary sound-box and horn of the early days?

A. Possibly I did not follow very well the reading of that article. I do not think that I got that particular statement. I do not believe that that device, without a baffle, would give a good response at as low a frequency as 60 cycles.

Q. What frequency did they commonly get with the old horn and sound-box combination?

A. With an ordinary horn of the size of two feet, there was a very marked dropping off in response at frequencies below 300 or 400 cycles per second, and at any frequency as low as 60 cycles per second the response would be practically nil.

Mr. Davis: That is all. May it be agreed that the actuating unit on this Exhibit 17 is a standard actuating unit of the Rola Company?

[fol. 150] Mr. Loftus: Yes, I thought I brought that out.

Testimony of Clair L. Farrand, for Plaintiff (Recalled in Rebuttal)

Clair L. Farrand was recalled as a witness on behalf of plaintiff and having been previously duly sworn testified as follows:

I have been familiar in actual commerce with the device manufactured and sold in accordance with the British patent to Brown, No. 29,833 of 1910. The device manufactured as shown in this patent, was a telephone receiver of the tuned frequency type; it was designed to resonate to one frequency, for telegraphic purposes. It was not adapted for receiving speech. It was designed to resonate to 1,000 cycles and was used as a part of a head set, a pair of these units being in the headset. The device was designed to be used pressed against the ear. Devices were subsequently manufactured under the British patent to Brown in the nature of loudspeakers. Brown manufactured in 1923 a loudspeaker using that type of diaphragm and actuating unit and later in the same year the R. E. Thompson Manufacturing Company, in the United States, manufactured a loudspeaker practically identical with the Brown loudspeaker, except as to the shape of horn. When the device was applied to a loudspeaker, the diaphragm was actuated at a greater amplitude than the armature over [fol. 151] the pole pieces. When it was used as an ear piece of a head set, the diaphragm moved a lesser distance than the armature over the pole pieces, that is, in a reduction ratio, whereas the loudspeaker actually had a step-up ratio. I have made a sketch of the old Brown device about which I have just testified. (Witness produces sketch.) This sketch is a correct illustration of it and shows the leverage of the lever A correctly. B indicates the pole pieces.

Plaintiff's Exhibit 25.—The sketch produced by the witness is received in evidence as Plaintiff's Exhibit 25.

As to whether these telephone receiving instruments of the headpiece type that are shown in the British patent to Brown operate on unconfined air in any sense—they operate confined air.

Mr. Davis: That is all.

Mr. Loftus: No questions.

Mr. Davis: I want to put in evidence some of these drawings which illustrate the devices involved in the early litigation. This one is the device involved in——

Mr. Loftus: I have not had an opportunity to see these drawings, or to see the device involved in the litigation, and I do not see how they can be offered in an informal manner like that, no proof of what was involved.

Mr. Davis: I can prove it by a witness.

The Court: It is like any other evidence, subject to proof.

[fol. 152] Testimony of Clair L. Farrand, for Plaintiff
(Recalled in Rebuttal)

Clair L. Farrand was called as a witness on behalf of plaintiff and having been previously duly sworn testified as follows:

Q. Mr. Farrand, were you familiar with the litigation between the Lektophone Corporation and the Western Electric Company and the Sylo Company, respectively?

A. Yes, I was.

Q. And you were acquainted with the type of loud-speaker that was employed by the Western Electric Company, and by the Sylo Company respectively?

A. Yes.

Q. I show you a drawing marked "Sylo and Western Electric Speaker," and would you tell me whether that is a correct representation of the loud speaker involved in the Western Electric and Sylo litigation?

A. Yes, it is a correct representation of the two types of speakers mentioned.

Q. And they were known as a double cone speaker?

A. Yes.

Q. Attached to that drawing is a copy of U. S. Patent No. 1,659,923; will you say whether or not that patent illustrates in figures 1 and 2 of the drawings the Western Electric and the Sylo type of loudspeaker?

A. Yes, it does, as to the diaphragm and actuating unit. [fol. 153] Plaintiff's Exhibit 26.—The drawing marked "Sylo and Western Electric Speaker" and U. S. Patent 1,659,923 are received in evidence as Plaintiff's Exhibit 26.

Q. You are familiar with the litigation against the Brandes Company in the Third Circuit?

A. Yes.

Q. There were two types of loudspeakers involved in that litigation?

A. Yes, one with an oval diaphragm, and one with a round diaphragm.

Q. I show you two drawings, and ask you whether or not they correctly represent those two types of loudspeakers.

A. Yes, they do. The smaller diaphragm shown in one view, actually was oval in shape.

Q. In those devices, what was the supporting rim between the rigid frame and the cone made of?

A. It was made of light rubber.

Plaintiff's Exhibit 27.—The drawings of the Brandes speakers identified by the witness are received in evidence as Plaintiff's Exhibit 27.

Q. Are you familiar with the device manufactured by the Crosley Company, and litigated in the Sixth Circuit?

A. Yes, I am.

Q. I show you a drawing with two views; will you say whether or not that is a correct illustration of the Crosley speaker?

A. Yes, it represents the Crosley speaker correctly.

Plaintiff's Exhibit 28.—The drawing of the Crosley [fol. 154] speaker identified by the witness is received in evidence as Plaintiff's Exhibit 28.

Q. Are you familiar with the loudspeaker that was enjoined by the district Court of the District of Delaware in a suit against the Algonquin Company?

A. I am.

Q. I show you a group of five photographs; can you say whether or not they are photographs of the Algonquin speaker in that case?

A. Yes, they are photographs of the Algonquin speaker, and its parts.

Plaintiff's Exhibit 29.—The group of photographs of the Algonquin speaker identified by the witness are received in evidence as Plaintiff's Exhibit 29.

Q. You are familiar with the loudspeaker manufactured by the Splitdorf Company, and enjoined in the District of New Jersey?

A. I am.

Q. I show you two photographs and a line drawing attached together; will you say whether or not they correctly represent the Splitdorf speaker involved in that case?

A. Yes, they do.

Plaintiff's Exhibit 30.—The group of photographs and the line drawing of the Splitdorf speaker identified by the witness are received in evidence as Plaintiff's Exhibit 30.

Q. Are you familiar with a loudspeaker manufactured by the Wirt Company, which was enjoined in the District Court for the Eastern District of Pennsylvania?

A. I am.

Q. I show you a group of five photographs and one line [fol. 155] drawing; will you say whether or not they correctly represent that speaker?

A. Yes, they do.

Plaintiff's Exhibit 31.—The group photographs and the drawing representing the Wirt speaker identified by the witness are received in evidence as Plaintiff's Exhibit 31.

Q. I have here a cone speaker with a frame; can you identify it?

A. That is a cone diaphragm from the Brandes speaker?

Q. The one involved in that litigation?

A. Yes.

Plaintiff's Exhibit 32.—The cone diaphragm from the Brandes speaker identified by the witness is received in evidence as Plaintiff's Exhibit 32.

Mr. Davis: That is all.

Cross-examination.

By Mr. Loftus:

Q. I notice none of these photographs of loudspeakers involved in the litigation carry any dimensions. I would like to have you enlighten us on that, Mr. Farrand. What was the diameter of the diaphragm in this Wirt speaker, Exhibit 31?

A. I do not recall the diameter of the speaker. It was, to the best of my recollection, about eight inches in diameter.

Q. Now, as a matter of fact, it was greater than nine inches, you know that, don't you, Mr. Farrand?

A. I said to the best of my recollection.

[fol. 156] Q. You don't know. Let me ask you as to Plaintiff's Exhibit No. 30, the Splitdorf speaker. What was the diameter of that diaphragm?

A. That diaphragm was an oval shape, and larger than the Wirt diaphragm. I would say its major axis was probably sixteen inches, and its minor axis eleven or twelve.

Q. Similarly, with respect to Exhibit 29, the Algonquin speaker, what was the diameter of that diaphragm?

A. The diameter of that diaphragm was about twelve inches.

Q. And likewise with respect to the Brandes speaker shown in Plaintiff's Exhibit 27—both of those had a mean diameter exceeding nine inches, did they not?

A. In the Brandes the diaphragms, as I recall, and as it is also marked on the diaphragms, it was less than nine inches—8⅞ inches, the diameter of the tympanum over all, and the conical portion was 7 15/16.

Q. I gathered from a reading of the opinion of Judge Buffington in that case that the mean diameter of this Brandes speaker exceeded nine inches. Do you agree with that?

A. May I refer to the second drawing there?

Q. Yes.

A. The smaller the device, the oval cone, I believe had one dimension that was greater than nine inches; I think the minor axis, however, was less; the circular diaphragm

we have one here in court, and it can be readily measured, [fol. 157] but I believe the tympanum was 8⅞ inches in diameter, and the conical portion was less.

Q. What is your definition of a tympanum?

A. I am using the word "tympanum" as used in the Hopkins patent, meaning the area enclosed within the rings.

Mr. Loftus: That is all.

Mr. Davis: Now, if your Honor please, I have one of these Stroh devices, and by stipulation of counsel it may be put in as an exhibit.

Mr. Loftus: I would be glad to have it in.

Mr. Davis: Then we offer this in evidence as Plaintiff's Exhibit 33. And it is stipulated that it is one of the devices of the Stroh British patent.

Plaintiff's Exhibit 33.—The Stroh device so offered was received in evidence as Plaintiff's Exhibit 33.

Mr. Loftus: I want to offer, in connection with the depositions which I read yesterday, a photograph of the Lumiere phonograph, accompanying the deposition of Mr. MacEwan, and ask that it be marked Defendant's Exhibit 34.

Defendant's Exhibit 34.—The photograph of the Lumiere phonograph, so offered, was received in evidence as Defendant's Exhibit 34.

Mr. Loftus: I also wish to offer a drawing of the Stroh violin, accompanying the deposition of Mr. Sooy, as Defendant's Exhibit 35. That is by stipulation.

[fol. 158] Defendant's Exhibit 35.—The drawing so offered is received in evidence as Defendant's Exhibit 35.

It is hereby stipulated and agreed that the foregoing is a correct copy of the condensed trial record with testimony stated in narrative form as agreed upon by the parties.

Wm. H. Davis, Chas. M. Fryer, Counsel for Plaintiff. Chas. E. Townsend, Wm. A. Loftus, Counsel for Defendant.

Approved: Frank H. Kerrigan, U. S. District Judge.

[Endorsed:] Filed December 26, 1928.

In United States District Court

Petition of Plaintiff, Lektophone Corporation, for an Order Allowing Appeal—Filed Sept. 12, 1928

The plaintiff in the above-entitled cause, Lektophone Corporation, feeling itself aggrieved by the final decree made and entered in said cause on July 30, 1928, dismissing the bill of complaint and awarding costs to defendant, comes now by its solicitors and counsel, and prays this Court for an order allowing said plaintiff to prosecute an appeal from the said final decree to the Honorable United States Circuit Court of Appeals for the Ninth Circuit [fol. 159] under and according to the laws of the United States in that behalf made and provided, and also that an order be made fixing the amount of security which said plaintiff shall give and furnish upon such appeal.

William H. Davis, Chas. M. Fryer, Solicitors and Counsel for Plaintiff.

[File endorsement omitted.]

In United States District Court

Assignment of Errors of Plaintiff, Lektophone Corporation—Filed Sept. 12, 1928

Now comes Lektophone Corporation, plaintiff in the above-entitled cause, and specifies and assigns the following as the errors upon which it will rely upon its appeal to the United States Circuit Court of Appeals for the Ninth Circuit from the final decree made and entered in said cause by this Honorable Court on the 30th day of July, 1928, dismissing the bill of complaint and awarding costs to defendant.

1. The above entitled court, to wit, the Southern Division of the United States District Court for the Northern District of California, Third Division, erred in not granting to the plaintiff the relief prayed for in its bill of complaint.

2. Said court erred in holding that the defendant has not infringed Claims 1 to 8, inclusive, of United States letters [fol. 160] patent to Marcus C. Hopkins, No. 1,271,529.

3. Said court erred in not holding that defendant has infringed Claims 1 to 8, inclusive, of United States letters patent to Marcus C. Hopkins, No. 1,271,529.

4. Said court erred in holding that Claims 29 and 30 of United States letters patent to Marcus C. Hopkins, No. 1,271,527, are invalid.

5. Said court erred in not holding that Claims 29 and 30 of United States letters patent to Marcus C. Hopkins, No. 1,271,527, are valid and that defendant has infringed each of said claims.

In order that the foregoing assignment of errors may be and appear of record, the said plaintiff presents the same to the Court and prays that such disposition may be made thereof as is in accordance with the laws of the United States.

Wherefore, said plaintiff prays that said decree be reversed and that said United States District Court in and for the Southern Division of the Northern District of California, Third Division, be directed to enter a decree in favor of said plaintiff and against the defendant, in the usual form, adjudging and decreeing said United States letters patent No. 1,271,529 and No. 1,271,527 valid and infringed by said defendant as alleged in the bill of complaint herein, granting to plaintiff all further relief prayed for in its said bill of complaint and referring the cause to a Master in Chancery for an accounting of damages and profits. [fol. 161] All of which is respectively submitted.

Wm. H. Davis, Chas. M. Fryer, Solicitors and Counsel for Plaintiff.

[File endorsement omitted.]

IN UNITED STATES DISTRICT COURT

ORDER ALLOWING APPEAL OF PLAINTIFF, LEKTOPHONE CORPORATION—Filed Sept. 12, 1928

In the above-entitled cause, the plaintiff Lektophone Corporation, having filed its petition for an order allowing an appeal, together with an assignment of errors—

Now, therefore, upon motion of William H. Davis and Charles M. Fryer, solicitors for said plaintiff, it is ordered that the said appeal be, and the same is, hereby allowed to said plaintiff, to the United States Circuit Court of Appeals for the Ninth Circuit from the final decree made and entered in said cause on July 30, 1928, dismissing the bill of complaint and awarding costs to defendant, and that the amount of the cost bond of plaintiff on said appeal be, and the same is, hereby fixed in the sum of Three Hundred Dollars ($300.00).

It is further ordered, that upon the giving of such cost bond a certified transcript of the record and proceedings herein be forthwith transmitted to said United States Circuit Court of Appeals.

[fol. 162] Dated September 12th, 1928.

Frank H. Kerrigan, District Judge.

[File endorsement omitted.]

Bond on appeal for $300.00, approved and filed September 12, 1928, omitted in printing.

[fol. 163] IN UNITED STATES DISTRICT COURT

JOINT PRÆCIPE AND STIPULATION FOR RECORD ON APPEAL—Filed Dec. 26, 1928

To the Clerk of the Court:

Please prepare a transcript of the record in the above-[fol. 164] entitled cause for the Circuit Court of Appeals, Ninth Circuit. The transcript should conform to the following terms of the joint præcipe and stipulation.

It is hereby stipulated by and between the parties hereto, through their respective counsel, that the printed record on appeal to the United States Circuit Court of Appeals for the Ninth Circuit in the above-entitled action shall consist of the following papers and documents:

1. Docket entires.
2. Bill of complaint.
3. Answer.

4. Amendment to answer dated November 16, 1926.
5. Amendment to answer dated November 30, 1927.
6. Evidence in narrative form.
7. Plaintiff's Exhibits 1, 2, 4, 5, 6, 7 and 25.
8. Defendant's Exhibits 9, 12, 19 and 34.
9. Opinion of Hon. George M. Bourquin.
10. Final decree.
11. Assignment of errors.
12. Petition for order allowing appeal.
13. Bond on appeal.
14. Order allowing appeal.
15. Citation on appeal.
16. This stipulation.
17. Stipulations and orders extending time for filing record in Circuit Court of Appeals.
18. Clerk's certificate.

[fol. 165] It is further stipulated and agreed that all exhibits which are not printed in accordance with this stipulation are physical exhibits and shall be produced in the Court of Appeals.

Wm. H. Davis, Chas. M. Fryer, Solicitors for Plaintiff. Chas. E. Townsend, Wm. A. Loftus, Counsel for Defendant.

The foregoing præcipe and stipulation is hereby approved and the Clerk of the court is directed to certify the record in accordance therewith.

Frank H. Kerrigan, United States District Judge.

Dated Dec. 26th, 1928.

[File endorsement omitted.]

Clerk's certificate to foregoing transcript omitted in printing.

[fols. 166-170] Citation in usual form, showing service on Chas. E. Townsend and Wm. A. Loftus, filed September 12, 1928, omitted in printing.

[fol. 171] Minute entry of argument and submission June 21, 1929, omitted in printing.

[fol. 172] In United States Circuit Court of Appeals

Order Directing Filing of Opinion and Filing and Recording of Decree—Sept. 23, 1929

By direction of the Honorable Frank H. Rudkin, Frank S. Dietrich and Curtis D. Wilbur, Circuit Judges, before whom the cause was heard, ordered that the typewritten opinion this day rendered by this Court in above cause be forthwith filed by the Clerk and that a decree be filed and recorded in the minutes of this court in accordance with the opinion filed.

In U. S. Circuit Court of Appeals

Upon Appeal from the United States District Court for the Northern District of California, Southern Division

Before Rudkin, Dietrich, and Wilbur, Circuit Judges

Opinion—Filed Sept. 23, 1929

Wilbur, Circuit Judge:

The appellant, being the owner and assignee of patents No. 1,271,529 and 1,271,527, issued to Marcus C. Hopkins, [fol. 173] July 2, 1918, upon applications filed July 14, 1913, claims that these patents and particularly claims 1 to 8 inclusive of the former and 29 and 30 of the latter are infringed by a radio loud speaker manufactured by the appellee, and seeks the usual remedies which were denied in the lower court.

The Hopkins patents were of sound-reproducing instruments for phonographs. The vibrating and sound reproducing element styled by the patentee, a tympanum, was in form a plane annulus from which projected a right cone with axis perpendicular to the plane of the annulus.

As stated in the patent, "the whole diameter of the tympanum * * * should exceed nine inches in order

that the conditions required to regenerate the sound waves in the manner above described shall be fulfilled. The case of the central conical portion 1 should exceed in area one-half of the effective area of the entire tympanum * * *. in other words the diameter of the base of said conical portion should be at least eight-tenths of the diameter of said aperture. The altitude of the conical portion 1 should be at least one-quarter of the diameter of its base."

The vibrations of the needle or stylus of the phonograph were imparted to the apex of the cone, by a system of levers which reduced the amplitude of the vibrations about one-half, but did not affect the number thereof. "It is of vital importance," the patent states, "that the tympanum be made of crisp, strong material, having considerable rigidity within itself, and it is also of vital importance that [fol. 174] the tympanum as a whole be extremely light and have as little inertia as possible without a weakening effect." The patent points out that the purposes of the conical form, is to give sufficient rigidity in the direction of the base so that it would move bodily without wave motions beng set up in the cone itself. "While I prefer," says the patent, "to construct the tympanum in the form described and shown with a smooth surface, especially in view of the ease of construction, yet it is possible to form radial or concentric corrugations in the plane peripheral portion and produce a light, stiff and very satisfactory article for the purpose. It is conceivable, too, that when the tympanum is provided with corrugations as just suggested some variation from the proportions above given may be made, but such variations will not be great."

The method of connecting the phonographic needle to the apex of the cone by levers which reduce the amplitude of the vibration and to the same extent increase the power is also involved in this litigation being covered by claims 29 and 30, above mentioned. We will defer the discussion of these claims until after disposition of the other questions.

As the matter of size and dimensions are important in connection with the prior art and the size of the alleged infringing diaphragm as will presently appear, we now quote from the file-wrapper of the patent, a letter addressed by the applicant's attorneys to the Commissioner of Pat-

ents Dec. 5, 1913, as follows: "with reference to claims 17, [fol. 175] which specifies a tympanum exceeding nine inches in diameter, it is submitted that the size of the tympanum is what enables it to effect direct regeneration of the sound. When a horn is employed for transferring high tension disturbances, the size of the tympanum is immaterial. Applicant has practically demonstrated that, to effect direct regeneration from the records of the sounds, a light, vibratile tympanum of substantially nine inches in diameter, or greater must be employed, to obtain faithful reproductions." This was in response to a letter from the Patent Examiner to the attorneys as follows: "Claim 17 is rejected on Kraemer (890,142). The size of the diaphragm is not a patentable limitation."

The defenses interposed by appellee are no invention and no infringement. The appellee's device, the Rola radio loud speaker, also has as a central conical portion a paper cone, but the rim or annulus is of soft kid leather. The paper cone is 7 9/16 inches, and the outer circumference of the movable portion of the annulus, or rim, is 9 11/16 inches. These dimensions are important as will shortly appear.

The Cone

The claims of the Hopkins patent for an "Acoustic Device" (1,217,529), are based primarily upon the proposition that a new method of propagation of self-sustaining sound waves without the intervention of a horn had been discovered. It is explained in the appellant's brief that the sound-box and horn method of reproduction of sounds de- [fol. 176] pends upon the vibration of a small diaphragm constituting one wall of a casing called a sound-box, which vibrates in the confined air in the sound-box and sets up sound waves or impulses of high pressure and small area, that these waves or impulses cannot travel through the air to the ear of the listener and there accurately reproduce the original sounds without modification and that the horn attached to the sound-box is for the purpose of reducing the pressure and extending the area of these sound-box impulses, while, on the other hand, the inventor claims that his device reproduces these large area, low pressure sound waves, without any horn, directly by the vibration

of the above-described tympanum, "and in this manner eliminates phonograph and horn sounds." Such an invention was a notable achievement in the art of reproducing sound, while the trumpet, bugle, horn, on the one hand, and the cymbal on the other, would seem to carry back to remote history these two methods of sound production as distinguished from reproduction.

In sound-reproducing instruments where the vibrations are produced mechanically, as a new sort of echo of sounds made by other instruments or methods, and at other times; the method of Hopkins, for producing sound waves of large area and low pressure so far as it involves a large paper cone, is clearly anticipated by a sound-reproducing device discovered and described by Sydney G. Starling, B. Sc., A. R. C. Sc., F. Phys. S., and W. Cole, F. L. S., in the [fol. 177] Talking Machine News of London, England, of July, 1907, under the title "The 'Vibratophone': A New Phonograph." The purpose of Starling and Cole as stated by them was as follows: "Our object in the first place, was to produce a diaphragm which would be large and rigid enough to set sufficient air in vibration to product audibility without the aid of a trumpet. Our paper cone must be looked upon as a modified diaphragm and not in any sense a trumpet." Their right cone was specified in the drawings as about eight inches in diameter at the base, with an altitude of about two and one-half inches. It will be noted that these dimensions of base and altitude are slightly larger than the minimum for the appellant's cone, whose base was 7.2 inches (eight-tenths of nine inches), and corresponding altitude one fourth of 7.2 or 1.8 inches. For a cone of 8 inches, appellant's corresponding altitude would be one fourth thereof or, 2 inches. Appellant says of the Hopkins patent that: "[illegible] stated object of this patent is the direct propagation of sound waves of correct intensity, amplitude, pitch and timbre on free air as distinguished from indirect reproductions of sounds by means of a 'reproducer or sound box and the horn' commonly used for sound production." The device of Starling and Cole, a rigid and thin paper cone of "cartridge drawing paper" vibrating with the phonograph needle or stylus, by the transmission of the vibrations of the stylus to the apex of the cone, was a workable device for a phonograph

and can be used as a radio loud speaker, but has the defect of blasting on certain lengths of sound waves particularly [fol. 178] where used with the relatively high power available in the radio art. This anticipation of the Hopkins patent would seem to eliminate his claims of prior discovery, so far as the conical part of the tympanum is concerned, and also so far as his claims are based upon a new and important discovery in the art of sound reproduction by utilizing a diaphragm acting directly on free air to produce self-sustaining sound waves, as distinguished from those produced in a closed sound box and amplified by a horn.

Aside from the pure echo the art of sound reproduction in modern times first attained important significance in the telegraph, then the telephone and then the phonograph and now the radio. The appellant seeks to gain the advantage of the application of his invention of a sound-reproducing device, intended primarily for the phonograph, to the new art of radio reproduction of sound. It is proper that it should do so, if its claims can be substantiated. It is, however, to be noted that the prior art of sound reproduction as developed in the telegraphic or telephonic art is also available to the radio engineer and inventor. The radio engineer, in his efforts for faithful sound reproduction, has at his command something entirely new to the art of sound reproduction as developed in the phonographic art, that is to say, relatively unlimited power. It is obvious that this asset in radio engineering may make it possible to utilize smaller diaphragms for the purpose of producing self-sustaining sound waves in free air, and hence make available patents and principles utilized in the art of sound reproduc- [fol. 179] tion before the Hopkins discovery appeared in this already greatly crowded field. The evidence in this case discloses that this can be done. Several loud speakers each constructed in accordance with a patent issued for telephonic or telegraphic or phonographic reproducing devices, each with a diaphragm smaller than the dimensions of the Hopkins diaphragm, all prior in the art to the Hopkins patents in suit, were demonstrated before the trial court, as radio loud speakers. The Maxwell device hereinafter described proved superior to the appellant's

device nor the appellee's without the addition of a baffle satisfactorily covered the range of sound vibration used in radio broadcasting of from 100 to 5,000 cycles. The appellee's device without a baffle was unsuccessful below 250 cycles. The test showed that the Hopkins device, constructed according to his patents, "rattled and blasted" at some frequencies below 8,000 although the exact point where such effects appeared is not made clear by the evidence, while the appellee's device without a baffle and with its construction of a soft kid annulus, with a felt welt to prevent the free passage of the air from back to front of the cone, did not "blast" up to 8,000 cycles.

If these prior inventions are applicable to the new art, and are diaphragms, vibrating in free air, and producing self-sustaining sound waves, without the aid of horn or trumpet, how would the appellant escape the claim that he had infringed these earlier patents if they were still in force, when he sought to invade this new field, or art, [fol. 180] with his later device where their earlier devices accomplish exactly what he claims to do and in the same manner?

If he were first in this field with his invention, how could these earlier devices, if later, instead of earlier, escape his claim of infringement?

"That which infringes if later would anticipate if earlier." (Knapp vs. Morss, 150 U. S. 221, 228, citing Peters vs. Active Mfg. Co., 129 U. S. 530, 537; Thatcher Heating Co. vs. Burtis, 121 U. S. 286, 295; Grant vs. Walker, 148 U. S. 547, 554; Gordon vs. Warder, 150 U. S. 47; Lektophone Corp. vs. Brandes Products Corp., 16 Fed. (2d) 934, 935.) The point is that in the new art the dimensions of the cone part of the diaphragm or of the diaphragm itself are relatively unimportant, and that this fact must be given due weight in determining the adaptability of the prior art to the new art. Appellant's patent is based on his representation therein, and on the representations of his attorney that in the propagation of self-sustaining sound waves from a phonographic record by a vibrating diaphragm, without the aid of a horn or trumpet, the size and dimensions are of the essence of the invention. Apparently this is not true in the radio art. The Rola cone, according to these representations of Hop-

kins, is too small to operate as a phonographic loud speaker, as the Hopkins device is claimed to do; and it required amplifying devices, increasing its power, and also a baffle and other devices to prevent sound interference, in order to operate successfully in the radio field.

[fol. 181] The Annulus

Before discussing the prior art of sound reproduction further we will consider an important phase of the appellant's contentions based upon his method of connecting the cone to the stationary ring by an annulus of the same material as the cone, constituting an integral part of the tympanum. The cone of Starling and Cole loud speaker was free at the base. The appellant places great stress upon the annulus and upon its being firmly secured to a rigid rim of metal, as distinguishing his device from theirs. It seems that when a cone of thin paper with a free base, such as Starling and Cole invented or proposed, is violently vibrated to reproduce sounds, on certain pitches, that is, with a certain number of vibrations, the free edge of the cone ceases to vibrate bodily with the balance of the cone. Its vibrating edge divides itself into nodes and loops—the nodes are the stationary points, and the loops the portion where the edge vibrates between these stationary points. This causes the cone to produce sounds of its own on certain pitches as well as to reproduce sound, and when used as a radio loud speaker causes sharp and unpleasant sounds known as "blasting" to intermingle unpleasantly with the music, or voice, or sound being reproduced. It is claimed that the Hopkins form of tympanum, a cone with an annulus at its base, fixed in place at its outer edge obviates this difficulty, and the evidence shows that it does so to some extent; and that the appellee's loud speaker by its method of securing the edge of the cone to the fixed frame by [fol. 182] limp leather produces the same result and therefore infringes this feature of the patent. Appellee's theory, on the other hand, is that this limp leather connection between its cone and annular metal rim entirely distinguishes it from the appellant's method of making connection thereto, by an integral part of his sounding device or tympanum. This distinction would seem to be well taken so far as sound generating properties are concerned, but upon the question

of the prevention of "bla ting" might be deemed an equivalent of the annulus of appellant's patent, and this point we will now consider.

In that connection it should be noted that Hopkins' patent says nothing of the blasting effect due to the vibration of a paper cone with a free edge. Nor is any claim made upon that point. Nor is it at all clear that the inventor had this point seriously in mind, although he does testify that in his experiments he noted this difficulty with a free edged cone.

On this branch of the subject two points are of importance,—first, the rights of an inventor to accidental and unanticipated results of his invention, and second the state of the prior art, as to anticipation on this matter of "blasting," for most of the prior patents presented in evidence were for a cone with edges firmly secured to a surrounding diaphragm, thus doing away with "blasting" so far as it can be done by firmly securing the edge of the annulus. "Doubtless a patentee is entitled to every use of which his [fol. 183] invention is susceptible, whether such use be known or unknown to him." Potts vs. Creager, 155 U. S. 597, 606. "An inventor is not called upon to state in his specifications or claims all the uses to which his invention may be put. When he has described and claimed his machine or combination and has secured a patent for it, he has the right to every use to which his device can be applied, and to every way in which it can be utilized to perform its function whether or not he was aware of these uses or methods or use when he claimed and secured his monopoly." American Cone and Wafer Co. vs. Denaro, 297 Fed. 913, 916, citing Roberts vs. Ryer, 91 U. S. 150; Miller vs. Mfg. Co., 151 U. S. 186.

These principles applied to the facts of this case would import into this new radio art prior patents, as well as the Hopkins patent, applicable to sound reproduction therein, from the prior arts of phonographic and telephonic sound reproduction, and would apply with equal force to all other such devices, whether atented or not, used in the art of sound reproduction. If the device of the appellant was an invention of a means of preventing "blasting" resulting from a conical vibrating element with free edges, it was anticipated by prior patents which will be shortly discussed.

The question of accidental or incidental discoveries is considered in a recent and difficult case by the Supreme

Court, Chief Justice Taft writing the opinion. Eibel Process Co. vs. Paper Co., 261 U. S. 45, at page 66. There the patent was granted Eibel for an improvement in the Four-
[fol. 184] dinier paper-making machine, which consisted solely in elevating the receiving end of the paper-making wire about 12 inches to speed up the flow of the pulp to an equality with that of the paper-making wire and thus greatly increasing the output of the machine. Barrett and Horn had received a patent for elevating the breast roll, and the paper-making wire three inches for the purpose of hastening the drainage of the water content of the pulp that flows on the wire constituting between 135 and 200 times the weight of the commingled paper-making fibres of the wood pulp. The opinion thus states the contention and the answer thereto. "It is contended on behalf of the defendant that whether Barrett and Horne perceived the advantage of speeding up the stock to an equality with the wire, yet the necessary effect of their devices was to achieve that result and therefore their machine anticipated Eibel. In the first place we find no evidence that any pitch of the wire, used before Eibel had brought about such a result as that sought by him, and in the second place if it had done so under usual conditions, accidental results, not intended and not appreciated, do not constitute anticipation." Citing Tilghman vs. Proctor, 102 U. S. 707, 711; Pittsburgh Reduction Co. vs. Cowles Electric Co., 55 F. 301, 307; Andrews vs. Carman, 13 Blatchf. 307, 323. It was therefore held that the previous adoption of a comparatively slight pitch of the screen, but for another and distinct purpose, did not constitute anticipation of the Eibel invention. Judge Coxe in an opinion of the Circuit Court of Appeals, Second Circuit, ap-
[fol. 185] plied this principle to an alleged anticipation by Hammonds patent of an improvement by Hilliard of a typewriter. "Assuming Hilliard's improvement to be present in the machine in evidence, it is difficult to believe that Hammond had an intelligent conception of the invention and failed to make the slightest allusion to it in his patent. If the new function existed in the machines made under the patent, and this is vehemently disputed, it was accidental, unrecognized by the patentee and no disclosure thereof made to the public." It was held on the authority of Tilghman vs. Proctor, 102 U. S. 707, *supra*, not to anticipate Hilliard's improvement. (Hilliard vs. Fisher Book Typewriter

Co., 159 Fed. 439, 441.) From these authorities it would seem to follow that Hopkins' invention did not cover the prevention of blasting effect due to the use of a free cone like Starling and Cole. But it is enough for the purposes of this decision to say that if Hopkins' patent did cover this accidental and incidental result of remedying a defect of slight importance in the phonographic art and of vast importance in the radio art because of the increased power available, such result was just as clearly anticipated by prior patents, and consequently the claims of the patentee in this suit, that the leather annulus of the appellee's device infringes the paper annulus of his patent because it prevents blasting, cannot be sustained on that ground.

We will now refer to some of these prior patents. The [fol. 186] first patent we will consider is that to Lumiere for an acoustical instrument, applied for June 30, 1909, and issued March 14, 1911, for sound reproduction. The object of the invention as stated in the patent was "to provide a diaphragm and a mounting therefore, by means of which sounds may be faithfully recorded and reproduced; which will be sensitive to sound waves and by the use of which the reproduction of sound will be improved and amplified." Among other things it was "to increase the active surface of a diaphragm of a certain given diameter; to increase the diameter of the diaphragm without making it liable to vibrate in parts, or to *set up nodes or inactive portions in the diaphragm* (italics ours), or in other words, to substantially increase the size of the diaphragm and, at the same time, have it vibrate throughout; * * *. It is found that the effect of bringing the surfaces of the vibrating body into a condition of molecular stress by torsion, is to reduce by a minimum the tendency of the vibrating body to form nodes during operation, so that the surface or surfaces of the diaphragm will vibrate as a whole and will not produce the disagreeable effect which is technically known as blasting or shattering." Thus it will be observed the inventor recognizes and attempts to overcome "blasting." The diaphragm is securely fastened to an outer metallic rim. The surface of the diaphragm is not flat but is a "fan-like series of radially disposed ridges and furrows, the ridges on one side of the diaphragm corresponding to the furrows on the other side of the diaphragm, and the furrows gradually [fol. 187] widening out and becoming less deep as they ap-

proach the edge of the diaphragm until at its perimeter the diaphragm lies in one plane." The form of the diaphragm might be described as a right cone, with an altitude equal to the depth of the furrow, about a half inch, containing about thirty-six ridges, each crest of a ridge, being a generator of the flat cone, lies in the surface of the cone, with the paper between these ridges projecting downward until the bottom of the "furrow" touches the base of the cone—in other words the ridges are in the plane of the surface of the cone and bottom of the furrows are in the plane of the base of the cone. The patentee comments on the diameter of his cone or diaphragm as follows: "Moreover, a diaphragm constructed in the manner above described can be usefully made of considerably greater diameter than has heretofore been possible. Experience has seemed to prove that a plane diaphragm of mica, or other material, such as is used at the present day if made of more than about three and one half inches in diameter loses in quality of reproduction, the reproduction becoming less musical and there being a liability to what is technically known as shattering due probably to the diaphragm not vibrating as a whole, i. e., the setting up of nodes in the diaphragm. I have found, however, that I am able to make a diaphragm according to the present invention as large as ten inches or more in diameter without impairing the quality of the reproduction, and by means of this diaphragm at the same time obtain a much greater volume of sound than with the smaller diaphragm. [fol. 188] This amplification of sound, which the patentee states in his patent he believes to be due to the increased diameter and surface of the diaphragm constructed as above described, in such that the "volume of sound produced is sufficient to enable me to dispense with the usual amplifying horn and in this way much of the metallic and hollow character usually associated with talking machine reproduction is eliminated." "Diaphragms may be made according to this invention of any suitable elastic material, such as paper (which may be varnished if desired), card, celluloid, metal or the like, and the surface, or surfaces of the diaphragm may be put under tension by any suitable means."

While the appearance of the appellant's device is quite dissimilar from that of the Lumiere, the general principles of both would seem to be the same. Lumiere gets uniform

vibration and large surface by tension and by fluting the paper diaphragm, and Hopkins gets both as does Starling and Cole by increasing the altitude of the cone. We use the phrase "cone" as applied to Lumiere's device not to emphasize a geometrical similarity between the two devices, although that is important, but to properly describe the tapering effect of his construction, and its relation to the plane at the perimeter into which ridges and furrows are flattened out. The pleating gives strength in the direction of the application of the vibrations, which is achieved by Hopkins by greater altitude of the cone. The Victor Talking Machine Company manufactured and sold about [fol. 189] 40,000 of these Lumiere diaphragms. In the above quotations from Hopkins' patent it will be observed that he speaks of a corrugated cone, and he might with equal accuracy have referred to a fluted cone as the equivalent of his uniform surface cone.

The Lumiere device presents the idea of a diaphragm of large surface generating a self-propagating sound wave, attached to a rigid frame. This device was operated at the trial as a radio loud speaker.

The Dann and Lapp patent, No. 338,660, issued March 23, 1886, for a telephone transmitter called for a plane diaphragm with a central conical portion. The plane portion attached to a rigid structure, with a four-inch central cone, the device described in this patent was operated successfully at the trial to produce self-sustaining sound waves. The Dann and Lapp patent has all the elements of the diaphragm or tympanum of the Hopkins patent, although the plane portion of the diaphragm is square instead of an annulus. If the material is changed to paper and the diameter of the cone increased in accordance with the teaching of Starling and Cole we have the device of Hopkins in substance, and almost duplicated in construction. Dann and Lapp do not confine their claims to transmitters but claim any other function to which it is applicable in the art of telephony, probably referring to receivers.

The Maxwell patent, No. 216,051, of June 3, 1879, applied for Nov. 7, 1878, for a telephone receiver or transmitter [fol. 190] with a sounding-board of soft pine wood, or other suitable material, with a circular opening covered by a funnel-shaped piece of sheepskin "or like material." The cone of eight-inch base, as the patent states, "I have also

found by experiment that a vibrator that is from seven to eight inches in diameter through the center from one outer edge to another is the most efficient, and that when they are much smaller than this the vibrations made by the vocal organs are of a nasal character," etc. These diaphragms are fastened to and upon the opposite side of a thin board of soft pine or other vibrating material. It is sufficient for our present purposes to note that the conical sheepskin diaphragm is only a part of the vibrating element, the balance being the thin board to which it is attached.

An apparatus such as is described in the Maxwell patent, with a single cone, and another with two cones apex to apex as therein described, were constructed and successfully operated as radio loud speakers at the trial.

In 1898 J. H. Rogers patented, No. 599,867, a telephone transmitter of the conical sounding-board type, secured to the vibrating electrode at its apex, with the mouth of the cone turned either toward or away from the electrode, as desired. This conical sounding-board he calls a target. Of it the patent states, "The target or sounding-board is by preference made of some thin light material, which is not detrimentally affected in any way by moisture. Celluloid has been used for this purpose, but other similar light [fol. 191] elastic substances will do as well." The patent states the cone form to be preferable, saying, "It is believed that the conical form is most efficient because of not having any particular tone of its own, but being capable because of its gradual diameters to respond to any and all tones." It is therein also stated "that the sounding-board may be made of any desired size." Here we have a free conical sounding-board operating to vibrate a magnet at its apex in response to sound waves, and thus set up vibrations in an electric current. Reversed as a transmitter it presents a thin vibrating conical sounding-board of any desired size operating in free air in response to fluctuating power applied at its apex.

The British patent office in 1911 granted to Sidney George Brown, an electrical engineer, a sound-reproducing device with a diaphragm very similar to that proposed by Hopkins, as some quotations therefrom will show, although, be it said, the dimensions of the diaphragm are not specified, and it is proposed to use it in the usual sound-box of a

phonograph or gramaphone presumably with the usual horn attachment.

"In the ordinary sound-box," the patent to Brown states, "arrangements of gramaphones and the like, one end of the stylus bar or lever is attached to the center of the diaphragm and the latter is gripped peripherially, with the result that since it is not absolutely free to vibrate freely at all points on its surface, its responsiveness to vibratory influences is very far from being efficient. Moreover, it is [fol. 192] usually comparatively heavy with the result that its inertia makes it sluggish in action.

"With a view to removing some of the constraint put upon the diaphragm by reason of its *periphical* mounting, it has been proposed to form it with a conical center portion and a resiliant flange portion so that the conical center portion the apex of which is secured to the stylus bar or lever, may vibrate as a whole; in such a construction, however, the dampening and constraining action of the flange portion is in my opinion too great to ensure acoustical efficiency. It has also been proposed to transmit the vibrations of the stylus bar to the conical diaphragm through a connecting rod and to mount the diaphragm peripherially by a flexible mounting of a folding character such as gold beaters skin to insure a movement of the diaphragm as a whole." He holds that the mounting should be at the apex of the cone and that the periphery must either be entirely free, or be connected to the casing or other stationary part by material so light and thin that no appreciable peripheral restraint is exercised. He thus leaves the cone either free or connected to the casing by "a ring of resilient material of extreme thinness," considerably thinner than the periphery of the conical diaphragm. The conical diaphragm he forms of thin aluminum or aluminum alloy of an average thickness of 2½ thousandths of an inch; for the ring or annulus he suggests "extremely thin resilient material such as glazed tissue paper one three-thousandth of an inch thick [fol. 193] or thin collodion film. The width of the annular space must be either so small that the two air regions on the two sides of the diaphragm may be considered as without communication with one another or the ring of material must be used. In other words, the annulus must be utilized as a buffer, if the cone is vibrated in relatively free air. The annulus, he says, may be connected with a stationary

ring. If the dimensions of this sound-box device of Brown be multiplied by four, if one may estimate its size, it would be approximately the size of the devices of the appellant and of the appellee. It would differ from both in the annulus or ring, in that the appellant's device treats the annulus as a part of the sound-producing diaphragm; it would in that respect more closely conform to the appellee's device, but the latter differs from the teaching of Brown's patent in that the flexible annulus is of relatively thick and heavy leather, operating as a drag on the movement of the periphery of the base of the conical diaphragm. Both the appellant's and the appellee's device have an annulus capable of acting as a buffer, to prevent to some extent the sound waves generated from the back of the cone interfering with those generated by the forward portion of the cone. So far as the case at bar is concerned, the notable teachings of the Brown patent are (1) a light conical diaphragm, (2) connected at its apex with the stylus or source or vibratory power, (3) connected by a plane annulus with a stationary ring or side of the device, (4) permitting the cone to vibrate [fol. 194] as freely as possible in the direction of its axis, (5) the ring to act as a buffer between the waves generated by the front and back portions of the conical diaphragm, (6) that the cone be of extremely light material. It differs most notably in size from the devices of the parties hereto, but its function is the same—to reproduce sound; and as has been pointed out it differs in the material of the annulus. The notable feature of this patent so far as the case at bar is concerned is the emphasis placed by the inventor, upon the annulus connection of the diaphragm and its function. The cone was not new in the art, neither was the idea of the cone connected at the periphery of its base by a resilient "flange." Brown's effort was to decrease the weight of the cone and to decrease the resistance of the flange or rim to the free vibrations of the cone.

Other patents were introduced in evidence but need not be specially considered. Enough has been stated to show that the use of a large cone of paper, or similar material, either unsecured or secured at its base to a vibrating or to a nonvibrating plane, actuated by impulses applied to its apex in free air, for the purpose of generating self-sustaining sound waves, was not new in the art of sound reproduction at the time of the Hopkins patents.

It is obvious that Hopkins entered a crowded field of effort for sound reproduction. The above-mentioned Maxwell patent of a large conical diaphragm with a base of from seven to eight inches in diameter attached to a thin vibrating plane, and secured to the side of a box enclosing [fol. 195] the cone, or two cones in alternate form, shows that the loud-speaking or self-sustaining sound reproducer was invented in connection with the art of telephony. Practically every element in the Hopkins patent was known to the prior art. It follows that if Hopkins by a nice and suitable adjustment of these elements produced a combination which in the form proposed was peculiarly suited to the problem it was intended to solve, that is, the reproduction of sound waves from a phonographic record in substantially the form and intensity of the sound to be reproduced, the patent should be confined to a narrow limit, and when an attempt is made to carry over into another art the monopoly granted by his patent in this narrow field of the phonographic art his claims of monopoly in this new art should be carefully scrutinized, for in this field the public is entitled to utilize all the old forms of sound-producing devices, if dedicated thereto, and if not, the owners of prior patents are entitled likewise to extend their monopoly thereto.

In short, the appellant seeks to crowd out of the new art improvements upon devices already in existence in the art of sound reproduction, on the ground that although different in form from his device, they constitute either colorable alterations thereof, or improvements thereon, necessarily utilizing his device as a base. But as has already been pointed out, his basic idea of a direct propagation of self-sustaining sound waves from a sounding-board or diaphragm operating in free air had been anticipated.

[fol. 196] On the question of infringement the appellee points out the flexible leather connection between the paper cone and the metal rim in its device; and that in the appellant's device this connection is an integral part of the vibratory diaphragm, and of the same crisp material required for the cone; that the outer edge of the appellee's flexible rim is less than the minimum declared necessary in the appellant's patent and in its file-wrapper letters to the Patent Office; it points out that, true to the statements in the Hopkins patent, appellee's cone device,

and flexible rim, and metal frame will not produce satisfactory sound reproduction without other accessories. To prove that fact the appellee constructed a loud speaker with these elements alone, and demonstrated to the satisfaction of the trial judge that such a speaker was unsatisfactory. The appellee points out that there is an inherent difficulty in the use of a free cone in a radio loud speaker due to the fact that the cone operated in free air tends to generate sound waves on both its inner and its outer surface. That while the wave on one side is being started by pressure, on the opposite side another wave is being started by decreasing pressure, both waves originating by the same forward or backward movement of the cone. These waves meeting at the edge of the cone do not harmonize and tend to modify and to some extent neutralize one another.

To overcome this tendency the appellee attaches the metal rings to which his annulus is secured to a board, called a baffle board, which extends the plane of the base of the [fol. 197] cone several inches, thus further separating the two conflicting sources of sound waves. The appellee also uses felt pieces, on the metal ring, or rim to prevent its vibration, and surrounds the back of the cone, with a container partly filled with felt. By these devices the appellee has perfected a loud speaker using a smaller cone than Hopkins thought possible in his claims for a patent. The appellee's device by reason of its dimensions does not infringe claims 1, 2, 3, 5, 6 or 7, of the Hopkins patent with respect to a tympanum "having a free area exceeding nine inches in diameter and a conical portion, the diameter is not less than eight-tenths of the diameter of the said free area." It is claimed, however, that it does infringe claims 4 and 8, which are as follows:

"4. An acoustic device, comprising a tympanum support having a circular aperture, and a light tympanum freely exposed to unconfined air and having its outer edge rigidly mounted on said support in said aperture; said tympanum having a central conical portion, the base of which exceeds in area one-half the effective area of the said tympanum; the tympanum being of sufficient area to impart to the surrounding free air, when vibrated, sound waves substantially corresponding in intensity to the original sound waves.

"8. An acoustic device, comprising a tympanum embodying a bodily movable, central conical portion, and an an- [fol. 198] nular rim which encircles said conical portion and which is rigidly supported, said conical portion being freely exposed on all sides to unconfined air and being of sufficient area to produce self-sustaining sound waves in the surrounding air when vibrated, substantially as described."

Claim number four is indefinite as to the size of the tympanum, but the patentee both in the patent and in his letters, in which he stated, and truthfully, that size is of the essence of his patent, gives nine inches as the minimum size workable in his plan for self-sustaining sound waves generated in free air by a phonographic needle. This claim, No. 4, is made evidently to cover the relative area of the annulus and the cone. The question of estoppel is raised by the appellee, who claims that the patentee is estopped to claim a lesser diameter than nine inches for the tympanum. Claim number eight is substantially identical with claim number four, except that in the latter the relative area of the base of the cone and of the tympanum is not stated and also is left indefinite. Here the diaphragm is merely described as composed of a central conical portion and an annular rim, freely exposed to unconfined air, "being of sufficient area to produce self-sustaining sound waves, in the surrounding air when vibrated substantially as described."

The representations or arguments of the patentee in the patent proceedings do not under the circumstances here disclosed constitute an estoppel. American Cone and Wafer [fol. 199] Co. vs. Denaro, 297 Fed. 913; Fullerton Walnut Growers Assn. vs. Anderson-Barngrover Mfg. Co., 166 Fed. 443; R. Hoe & Co. vs. Goss Printing Press Co., 30 Fed. (2d) 271, 275. We must, however, either hold these claims void for indefiniteness or that the claim only covers a slightly smaller or larger cone which will, in the operation of a phonograph (by the use of lever connections, decreasing the amplitude of vibration about one-half), produce sound waves of such volume as will be "of substantially the same intensity as the original." In either case it is clear that the defendant-appellee does not infringe said claims for so used its alleged infringing diaphragm would not accomplish the object or measure up to the standard set up by the appellant.

We have not so far alluded to the commercial aspects of the case. The cone type of radio loud speaker is widely used. The appellant's witnesses estimate that a million and quarter of the type here involved have been sold. The appellant has never manufactured a radio loud speaker. The first radio loud speaker of the cone type was made in 1921 by Mr. Ferrand, a licensee of the appellant and now a stockholder in the appellant corporation, "after several years experiment." If the Hopkins patent was a basic and generic patent on the form and use of a large diaphragm or soundingboard to produce self-sustaining sound waves, this great production would be strong evidence of its utility, and consequently of his invention, but the evidence here simply indicates that the appellant has been remarkably [fol. 200] successful in levying tribute upon a new and rapidly extending art. He has succeeded in asserting a monopoly in a new field, not in contemplation at all by the patentee when he made his invention. We cannot see that this success is as persuasive as such evidence sometimes is, as to the exercise of the inventive faculty. The appellant has been active in asserting its alleged monopoly, and has thus, no doubt, forced many to buy their peace in a situation so full of doubt, confronted by such dire penalties, as are involved in unsuccessful patent litigation. See Lektophone Corporation vs. Sylo Lighting Fixture Co., 11 Fed. (2d) 421, 16 Fed. (2d) 7; Lektophone Corp. vs. Western Electric Co., 16 Fed. (2d) 10, 20 Fed. (2d) 150; Lektophone Corp. vs. Brandes Products Corp., 20 Fed. (2d) 155; Lektophone Corp. vs. Rola Co., 27 Fed. (2d) 758. We are in accord in general with the views expressed by the Circuit Court of Appeals of the Second Circuit in Lektophone Corp. vs. Sylo Lighting Co., 16 Fed. (2d) 7, supra, and in Lektophone Corp. vs. Western Electric, 16 Fed. (2d) 10, supra, as to noninfringement, and like that court find it unnecessary to pass upon the validity of the patent, limited as its interpretation must be by the state of the prior art, and by the intended application of the device to a phonograph. We are also in accord with the decision of that Circuit Court and that of the Circuit Court of Appeals of the Third Circuit in Lektophone Corp. vs. Brandes Products Corp., 20 Fed. (2d) 155, holding invalid claims 29 and 30 of patent No. [fol. 201] 1,271,527, but we cannot follow the latter decision

in so far as it holds that a flexible, nonresonant rim or annulus connecting the cone of the diaphragm to the stationary metal rim is the equivalent in a sound-reproducing device of the flat rim or plane annulus of Hopkins tympanum, for the reasons heretofore stated; namely, that Hopkins made no claim to a nonresilient connection of the cone to the metal frame, as a preventative of blasting, and that such a flexible connection was anticipated as above indicated as early as 1879 by Maxwell and in 1910 by Brown. Futhermore the method of connecting a central vibrating cone at the base of its perimeter to a circumscribing vibrating body, square or circular in perimeter, and of securing the latter to a stationary frame was frequently used in the art of sound reproduction, as appears from the above discussion.

In this connection it should be observed that the Appellate Court is somewhat in the same position, with reference to the experiments, or demonstrations conducted in the presence of the Trial Court, as it is with reference to the witnesses which appear before it. Unless we are, in effect, to try the case de novo on appeal, which is not permissible, we must rely upon the judgment of the Trial Court as to what was demonstrated before it. One of the most unpromising of sounding-board exhibits, that is, one departing most from the appellant's specifications, for a sounding-board or diaphragm, was, without objection, demonstrated during the argument before us. A large plane and a very [fol. 202] small cone in this demonstration seemed to satisfactorily reproduce music, being broadcast by radio. It appears from the record that most of the exhibits constructed by the appellee in accordance with prior patents, satisfactorily reproduced self-sustaining sound waves, and satisfied the Trial Judge that the appellant's device was merely an enlargement of designs already available to the radio art in the Patent Office, and also that the appellee's device operated with the parts alleged to infringe the appellant's patent failed to satisfactorily reproduce such sounds within the required range, thus proving to his satisfaction that the flexible elastic, nonresonant annulus was not the equivalent of the appellant's resonant annulus, and also that the appellee's diaphragm was too small without other accessories to operate as the appellant's device was claimed to do. That is to say, the proof before the Trial

Judge showed to his satisfaction that the attorneys for the patentee told the truth when they represented to the Patent Office that the dimensions stated in their application were of the essence of the invention. Our view as to annulus of the diaphragm in the appellant's device seems to be in accord with that expressed by Mr. Justice Tomlin of the High Court of Justice of Chancery Division of Great Britain in dealing with the alleged infringement of the appellant's device by the diaphragm of the Mascot Radio loud speaker, having an annulus of thin, nonresonant paper.

We must either hold that the appellant's device is void for lack of invention or that he is so narrowly confined by [fol. 203] the specified dimensions and claims of his patent that the smaller device of the appellee, with its limp leather annulus, does not infringe. It is sufficient for the purpose of this case to follow the latter course, as the Trial Judge did.

Judgment affirmed.

[File endorsement omitted.]

IN UNITED STATES CIRCUIT COURT OF APPEALS FOR THE NINTH CIRCUIT

No. 5712

LEKTOPHONE CORPORATION, a Corporation, Appellant,

vs.

THE ROLA COMPANY, a Corporation, Appellee

Appeal from the District Court of the United States for the Northern District of California, Southern Division

DECREE—Filed Sept. 23, 1929

This cause came on to be heard on the Transcript of the Record from the District Court of the United States for the Northern District of California, Southern Division, and was duly submitted.

On consideration whereof, it is now here ordered, adjudged, and decreed by this Court that the decree of the

[fol. 204] said District Court in this cause be, and hereby is, affirmed, with costs in favor of the appellee and against the appellant.

It is further ordered, adjudged and decreed by this Court that the appellee recover against the appellant for its costs herein expended, and have execution therefor.

[File endorsement omitted.]

IN UNITED STATES CIRCUIT COURT OF APPEALS

ORDER STAYING ISSUANCE OF MANDATE—Filed Oct. 21, 1929

Upon application of Mr. Charles M. Fryer, on behalf of counsel for the appellant, and good cause therefor appearing, it is ordered that the issuance, under Rule 32, of the mandate of this court in the above cause be, and hereby is stayed to and including November 23d, 1929; and in the event the petition for a writ of certiorari to be made by the appellant herein be docketed in the Clerk's office of the Supreme Court of the United States on or before said date, then the mandate of this court is to be stayed until after the said Supreme Court passes upon the said petition.

Frank H. Rudkin, United States Circuit Judge.

Dated San Francisco, California, October 21, 1929.

[File endorsement omitted.]

[fols. 205-207] Clerk's certificate to transcript of record omitted in printing.

[fol. 1] PLAINTIFF'S EXHIBIT No. 1

[Endorsed:] No. 1726—Eq. United States District Court. Lektophone vs. Rola. Pltfs. Exhibit No. 1. Filed 5/10/28. Walter B. Maling, Clerk. By A. C. Aurich, Deputy Clerk.

No. 5712. United States Circuit Court of Appeals for the Ninth Circut. Filed Feb. 5, 1929. Paul P. O'Brien, Clerk.

(Here follows drawing, side folio 2)

[fol. 3] United States Patent Office

Marcus C. Hopkins, of New York, N. Y., Assignor, by Mesne Assignments, to Lektophone Corporation, of New York, N. Y., a Corporation of Delaware

229,014

Acoustic Device

Specification of Letters Patent.

1,271,529. Patented July 2, 1918

Original application filed July 14, 1913. Serial No. 778,826. Renewed March 22, 1918, Serial No. 224,048. Divided and this application filed April 17, 1918. Serial No. 229,014.

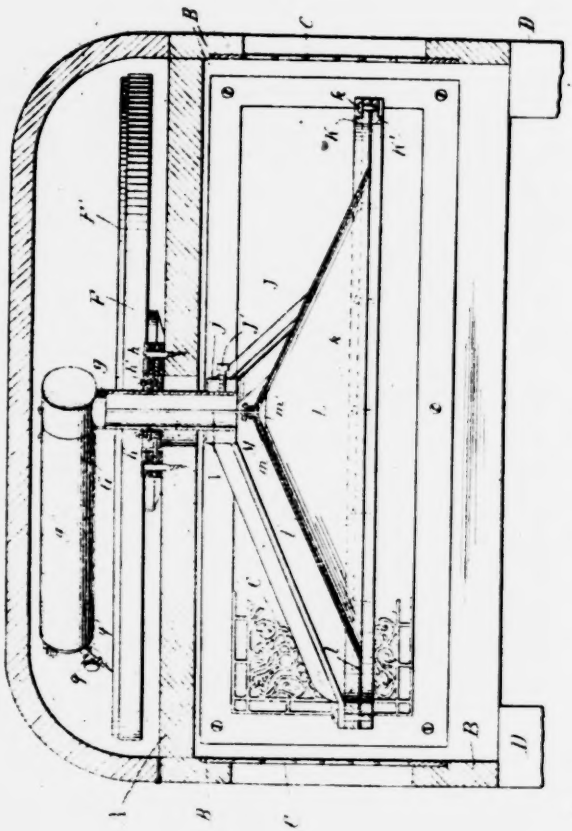
To all whom it may concern:

Be it known that I, Marcus C. Hopkins, a citizen of the United States, residing in the borough of Manhattan, city, county, and State of New York, have invented certain new and useful Improvements in Acoustic Devices; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to instruments which reproduce sounds; and is particularly directed to the attainment of a direct propagation, in free air, from a record or equivalent element subjected to the action of the original sound waves or vibrations, of self-sustaining sound waves substantially corresponding in intensity and amplitude, as well as in pitch or timbre, to the said original sound waves as distinguished from an initial generation of violent air disturbances in a confined space, and a subsequent transformation of such disturbances into self-sustaining sound waves by means of a megaphone, horn or other amplifier.

M. C. HOPKINS.
ACOUSTIC DEVICE.
APPLICATION FILED APR. 17, 1918.

1,271,529. Patented July 2, 1918



Inventor
Marcus C. Hopkins
By Attorneys
Pennie, Davis, Marvin & Edmonds

In the case of a talking machine, the device employed to propagate the regenerated sound waves in air comprises the reproducer or sound-box and the horn; but the reproducer alone is incapable of propagating sound waves of the character above stated because of the fact that the air disturbances which are produced by its diaphragm and which issue through its mouth-piece are almost immediately dissipated in heat or in waves which are not heard at any considerable distance if the horn be removed. Consequently, it is usual in all instruments of the class indicated to employ an amplifier of some sort to resist transformation into heat and to control the lateral form of the wave during a progressive spreading action which is accompanied by a lessening of the violence of the disturbance until a wave front of great area is attained having a movement appropriate to the sound conductivity of air. In this way, it has been found practicable to transform a satisfactory part of the energy, obtained from a moving record, into self-sustaining sound waves in air; but in every instance such method has been accompanied by distortions of the true recorded sounds in the reproducer, and more particularly in the horn or amplifier, giving rise to those characteristic sounds known as phonograph and horn sounds. These distortions of the true sounds are in a measure impressed upon the record in its making, but are more noticeable in the reproduction, where a suppression of character and overtones, the loss of timbre in instruments and the voice, and the accentuation of notes of certain pitch, so change the recorded number that a faithful reproduction is not obtained.

It is the object of the present invention to regenerate the original sounds directly from the record or other element subjected to the action of such sounds, without interposition of a confined body of air and without the employment of a restrictive transformer, such as a horn. According to the invention, the sound regenerator comprises a tympanum of relatively great area freely exposed to unconfined air, in which the sounds are to be propagated; the vibrations produced by the record or its equivalent,—that is, the element on which the original sounds or sound waves are recorded, or which is otherwise subjected to the vibrating action of said sounds or sound waves and may, therefore, be termed the "sound-vibrated" element—being faithfully trans-

mitted to the tympanum in such manner that the latter excites directly in the free air surrounding it, sound waves of an intensity and amplitude, substantially corresponding to the original sound waves. In other words, the original sounds are directly regenerated by the vibrating tympanum without the interposition of a restrictive or sound-modifying transformer.

The invention consists, briefly, in the provision of a tympanum of novel construction, which is capable of responding to the high frequency vibrations employed in the reproduction of sounds, and of imparting these vibrations to a large body of air; and it is to be considered as a division of the invention shown and described in my prior application, renewed March 22, 1918, No. 224,048.

The accompanying drawing illustrates the improved tympanum incorporated in a sound-reproducing machine of the kind disclosed in said application, the single figure being a vertical sectional view taken transversely through the [fol. 4] machine. Reference may be had to this application for a disclosure of the complete machine; and in order to facilitate an understanding of the present invention as compared with such disclosure, the same reference characters will be employed as in the said earlier application to indicate corresponding parts.

The machine represented in said drawing is mounted within a cabinet having a deck A, upon which the motor (not shown) and the sound regenerator are mounted. Side walls B extend downwardly from the edges of the deck A, and are preferably apertured on all sides and provided with open-work grills C, which afford substantialy uninterrupted air paths for the sound waves from the interior of the cabinet in all directions laterally to the surrounding atmosphere. In the machine shown, the cabinet is bottomless and provided with legs D at its four corners. The motor may be of any suitable type, and is connected to drive the shaft of the turn-table F through the intermediary of gearing, as is usual, said shaft projecting upwardly through the deck A. The turn-table carries the record F', which in this instance is the element directly acted upon by the original sound vibrations which are to be subsequently regenerated or reproduced; that is to say, the record, in the present construction, is the "sound-vibrated" element.

The sound regenerator has a right-angled tubular support G, the vertical arm g of which is engaged at dimetrically-opposite points by bearing screws h', which project inwardly from and are carried by a ring h of larger diameter than the said arm g, as described in said prior application. The screws h' form a horizontal axis perpendicular to the horizontal arm g'' of the right-angled support G, about which axis the arm g'' can swing in a vertical plane, the vertical arm g the while being inclined within the ring h. The latter forms part of an annular bearing device secured upon the deck A, the open central portion of which device alines with an opening of larger diameter in said deck, and the said vertical arm g of the support G extends downwardly through these openings and has its lower extremity fitted in the hub j of a conical spider J and fastened to the same by a set screw j'.

The spider J in the present construction has three arms, only two of which appear, however; and to the lower ends of these arms there is secured by screws an annulus consisting of two ponderous rings, K, K' of metal, which are clamped together by screws k spaced at short intervals. Two of the three arms of the said spider are screwed tightly to the rings K K', and the third is so arranged that the rings K, K' can be secured at varying distances from the foot of this third arm, there being sufficient spring in the spided arms to permit of an adjustment at this point of one-quarter of an inch or so, if desired. This detail is illustrated in my earlier case, and for that reason is not represented in the present case.

The tympanum L, which forms the subject of the present case, is constructed of light, vibratile material and has an annular plane peripheral portion or supporting rim l, the outer edge of which is tightly-gripped and rigidly supported between the rings K, K', and a central conical portion l' rising from the inner edge of the said rim l. If satisfactory regeneration of sounds from a record or other sound-vibrated element is to be had, the whole diameter of the tympanum, that is, the diameter of the aperture in the rings K, K' should exceed nine inches in order that the conditions required to regenerate the sound waves in the manner above described shall be fulfiled. The base of the central conical portion l' should exceed in area one-half of the effective area

of the entire tympanum, that is, the area of the aperture in the rings K, K′; or in other words, the diameter of the base of said conical portion should be at least eight-tenths of the diameter of the said aperture. The altitude of the conical portion l′, should be at least one-quarter of the diameter of its base.

It is, of course, possible to make some variation from the approximate sizes given without materially altering the result; but if the tympanum is constructed as shown in the drawing, any great variation from these proportions will be found to affect the character of the reproduction. It is of vital importance that the tympanum be made of crisp, strong material, having considerable rigidity within itself, and it is also of vital importance that the tympanum as a whole be extremely light and have as little inertia as possible without a weakening effect. The tympanum is shown of conical form with a smooth surface, and this has been found to be very satisfactory. The conical shape is given the tympanum so that shocks or vitrations impressed upon the apex of the cone in a direction toward its base will move the whole cone bodily, the strains being imparted edgewise of the material and no wave motions being set up in the thin material of the cone. The curvature of the walls of the cone precludes the setting up of waves in the material; and the intended object, a simultaneous movement of the whole conical portion of the tympanum, is thus attained. While I prefer to construct the tympanum in the form described and shown with a smooth surface, especially in view of the ease of construction, yet it is possible to form radical or concentric corrugations in the plane peripheral portion l and produce a light, stiff and very satisfactory article [fol. 5] for the purpose. It is conceivable, too, that when the tympanum is provided with corrugations as just suggested, some variation from the proportions above given may be made; but such variations will not be great. The tympanum should preferably be constructed of a colloidal substance, and should be from 3 to 20 thousandths of an inch in thickness according to the crispness or stiff character of the material used. Compressed fibrous material, such as hot pressed paper or fiber, has been found to act satisfactorily.

It will be noted that in the construction illustrated, the arms of the spider J incline downwardly to correspond with the conical shape of the tympanum L, the apex of the conical portion of the tympanum pointing upwardly toward the deck A of the cabinet, and, also, that the concave side of the said tympanum is open to the surrounding atmosphere through the open bottom of the cabinet, no obstructions being presented to the sound waves issuing from the concave surface of the tympanum.

A cap M is secured to the apex of the conical portion 1 of the tympanum, and this cap should be of more rigid construction than the remainder of the tympanum and should preferably be three-eighths of an inch or more in diameter. I prefer to make the cap M of metal, extremely light but very rigid, and in the form of two cones m, m′ screwed tightly together upon opposite sides of the tympanum so as to grip the material thereof with their edges. In order that a tight and positive application of the cones forming the cap M to the conical portion of the tympanum may be had, it is preferably to form the inner cone m′ of lesser angle, and the outer cone m of greater angle than the said conical portion, in which case their edges will securely grip the tympanum material when they are fastened together.

The vibrations or sound waves originally imparted to the record or its equivalent may be transmitted therefrom to the tympanum to vibrate the same in the manner and by means of the mechanism shown and described in my aforesaid application above identified, or by means of some other approved transmission means or mechanism, as will be understood. In any event, such means or mechanism forms no part of the present case, however, and for that reason requires no extended disclosure. It is believed sufficient to state, therefore, that in the arrangement illustrated the mechanism in question is located within the horizontal arm g″ of the support G, and is connected at its forward end with the stylus holder q, the other end of said mechanism having connected to it a vertical rod V, which extends downwardly through the interior of the vertical arm g of the support and is rigidly secured to the cap M of the tympanum. In consequence, the vibrations of the stylus q′ mounted in said holder and produced in the usual way by the phonic lines on the record, will be transmitted from the stylus through the transmission mechanism to the rod V,

which will be vibrated endwise, the endwise vibrations of said rod being directly impressed upon the tympanum L.

I claim:

1. An acoustic device, comprising a tympanum rigidly supported at its periphery and having a free area exceeding nine inches in diameter and a conical portion, the diameter of which is not less than eight-tenths of the diameter of said free area.

2. An acoustic device, comprising a tympanum rigidly supported at its periphery and having a free area exceeding nine inches in diameter and a conical portion, the diameter of which is not less than eight-tenths of the diameter of said free area, said conical portion being rigid in the direction of the axis of the tympanum.

3. An acoustic device, comprising a tympanum rigidly supported at its periphery and having a free area exceeding nine inches in diameter and a conical portion, the diameter of which is not less than eight-tenths of the diameter of said free area, the altitude of said conical portion being substantially one-quarter of the diameter of its base.

4. An acoustic device, comprising a tympanum support having a circular aperture, and a light tympanum freely exposed to unconfined air and having its outer edge rigidly mounted on said support in said aperture; said tympanum having a central conical portion, the base of which exceeds in area one-half the effective area of the said tympanum; the tympanum being of sufficient area to impart to the surrounding free air, when vibrated, sound waves substantially corresponding in intensity to the original sound waves.

5. An acoustic device, comprising a tympanum support having a circular aperture, and a light vibratile tympanum exceeding nine inches in diameter, having its outer edge rigidly mounted on said support; said tympanum being shaped to provide an annular rim adjacent said support, and a conical portion springing from the inner edge of said annular rim, the diameter of the base of said conical portion being not less than eight-tenths of the said circular aperture in said support.

6. An acoustic device, comprising a tympanum support having a circular aperture, and a light vibratile tympanum mounted in said aperture and having its outer edge secured to said support; said tympanum being shaped to provide an

M. C. HOPKINS.

SOUND REGENERATING MACHINE.

APPLICATION FILED JULY 14, 1913. RENEWED MAR. 22, 1918.

1,271,627. Patented July 2, 1918.

5 SHEETS-SHEET 1.

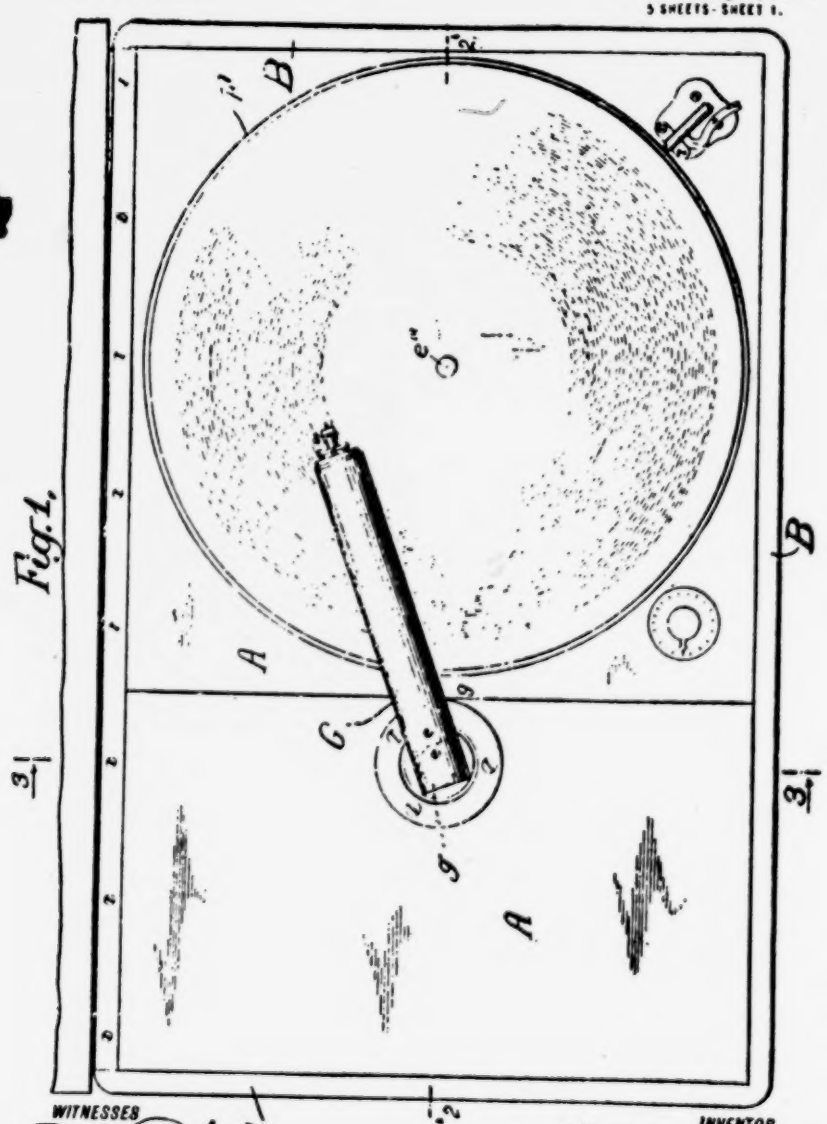


Fig. 1.

WITNESSES

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SOUND REGENERATING MACHINE.

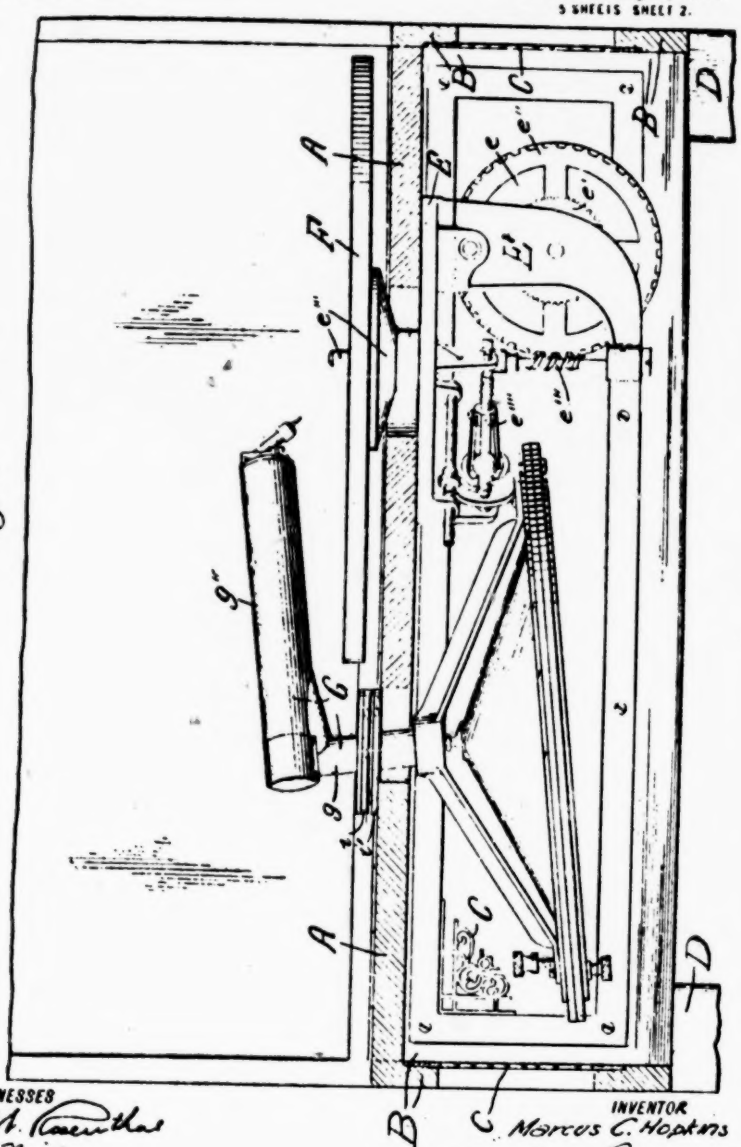
APPLICATION FILED JULY 14, 1913. RENEWED MAR. 22, 1918.

1,271,527.

Patented July 2, 1918.

5 SHEETS SHEET 2.

Fig. 2.



WITNESSES

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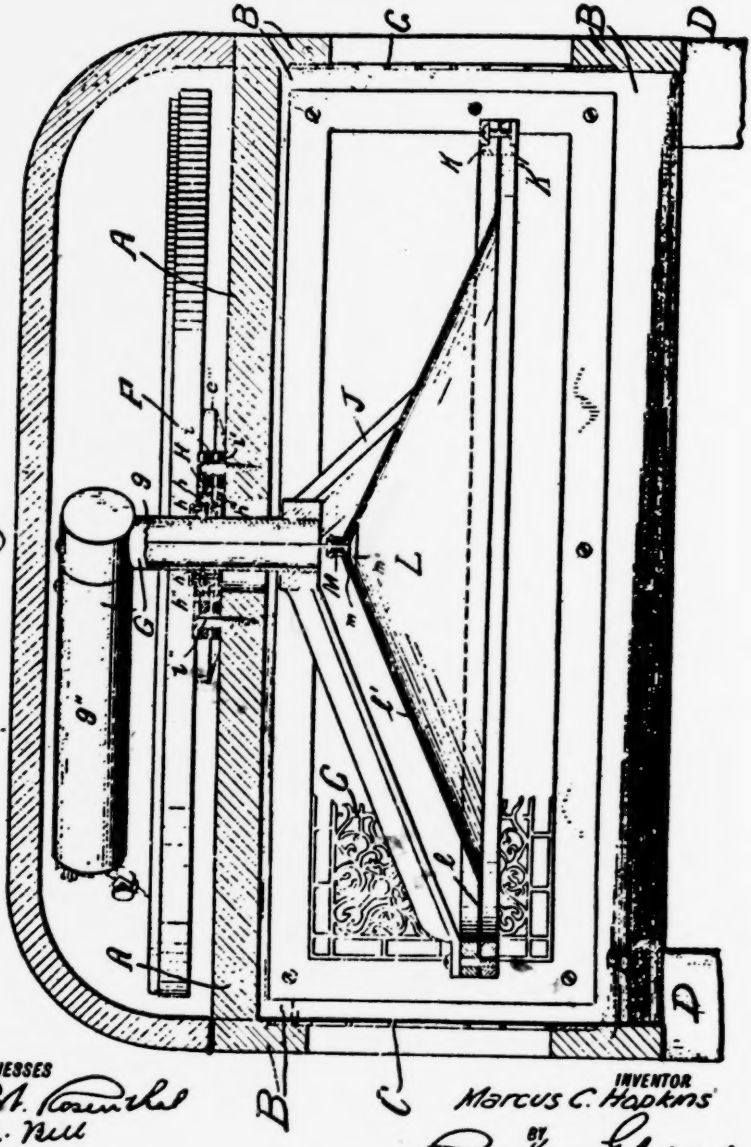
SOUND REGENERATING MACHINE.

APPLICATION FILED JULY 14, 1913. RENEWED MAR. 22, 1918.

1,271,527. Patented July 2, 1918.

5 SHEETS—SHEET 3.

Fig. 3.



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SOUND REGENERATING MACHINE.

APPLICATION FILED JULY 14, 1913. RENEWED MAR 22, 1918.

1,271,527. Patented July 2, 1918.

3 SHEETS-SHEET 4.

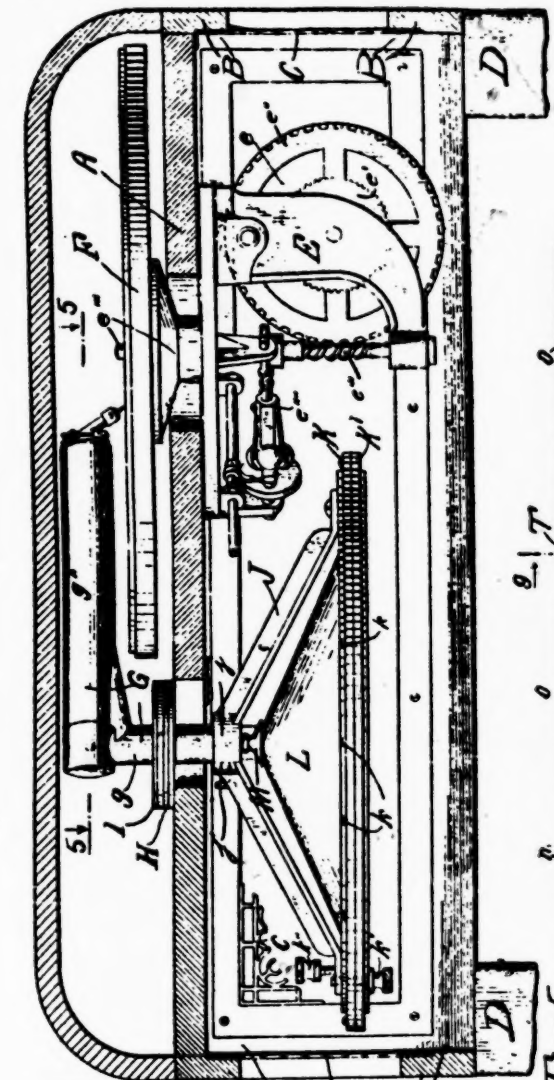

Fig. 4.

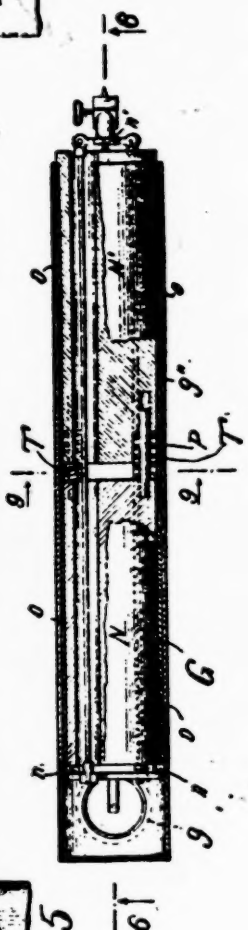

Fig. 5.

WITNESSES

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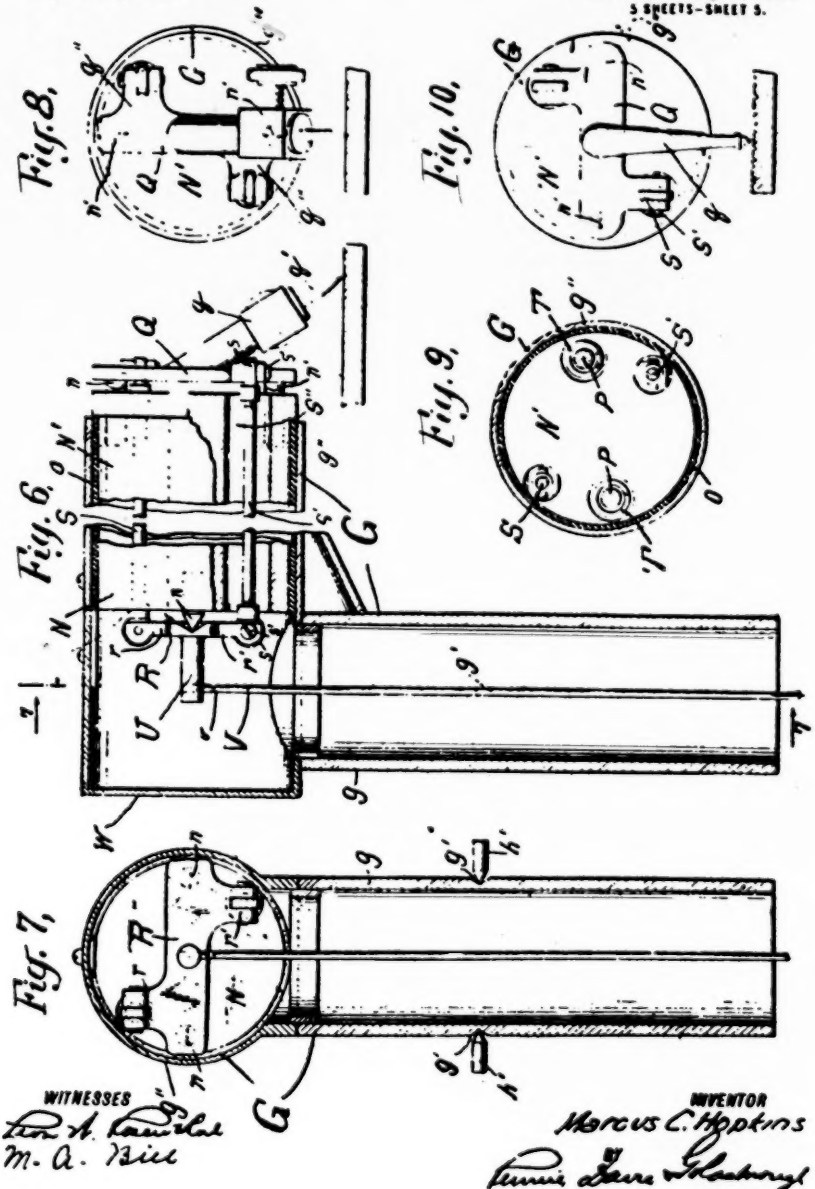
SOUND REGENERATING MACHINE.

APPLICATION FILED JULY 14, 1913. RENEWED MAR. 22, 1918.

1,271,527. Patented July 2, 1918.

5 SHEETS—SHEET 5.



WITNESSES

M. A. Bill

INVENTOR

Marcus C. Hopkins

ATTORNEYS

[fol. 6] annular rim, the outer diameter of which exceeds nine inches, and a conical portion springing from the inner edge of said annular rim, the altitude of said conical portion being substantially one-fourth of the diameter of its base.

7. An acoustic device, comprising a tympanum support having a circular aperture exceeding nine inches in diameter, and a light vibratile tympanum mounted in said aperture and having its outer edge rigidly secured to said support; said tympanum being shaped to provide an annular rim adjacent said support, and a conical portion springing from the inner edge of said annular rim, the diameter of the base of said conical portion being not less than eight-tenths of the diameter of said circular aperture, and the altitude of said conical portion being substantially one-quarter of the diameter of its base.

8. An acoustic device, comprising a tympanum embodying a bodily movable, central conical portion, and an annular rim which encircles said conical portion and which is rigidly supported, said conical portion being freely exposed on all sides to unconfined air and being of sufficient area to produce self-sustaining sound waves in the surrounding air, when vibrated, substantially as described.

In testimony whereof I affix my signature.

Marcus C. Hopkins.

[fol. 7] PLAINTIFF'S EXHIBIT No. 2

[Endorsed]: No. 1726. United States District Court. Lektophone vs. Rola. Plfts. Exhibit No. 2. Filed 5/10/28. Walter B. Maling, Clerk. By A. C. Aurich, Deputy Clerk.

No. 5712. United States Circuit Court of Appeals for the Ninth Circuit. Filed Feb. 5, 1929. Paul P. O'Brien, Clerk.

(Here follow drawings, side folios 8, 9, 10, 11, and 12)

[fol. 13] United States Patent Office

Marcus C. Hopkins, of Jersey City, New Jersey, Assignor, by Mesne Assignments, to Lektophone Corporation, of New York, N. Y., a Corporation of Delaware

Sound-Regenerating Machine

Specification of Letters Patent

1,271,527. Patented July 2, 1918

Application filed July 14, 1913. Serial No. 778,826. Renewed March 22, 1928. Serial No. 224,048

To all whom it may concern:

Be it known that I, Marcus C. Hopkins, a citizen of the United States, residing at No. 2859 Boulevard, Jersey City, county of Hudson, and State of New Jersey, have invented certain new and useful Improvements in Sound-Regenerating Machines; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to instruments which reproduce sounds, such as the talking machine and the phonograph, and is particularly directed to the attainment of a direct propagation in free air from a record of self-sustaining sound waves substantially corresponding to the original recorded sounds in intensity or amplitude as well as in pitch and timbre, as distinguished from an initial generation of violent air disturbances in a confined space, and a subsequent transformation of such disturbances into self-sustaining sound waves by means of the magaphone or trumpet, commonly employed with most existing machines.

The device employed to propagate such regenerated sound waves in air from a record I herein term a "regenerator," and, this device in the phonograph and talking machine comprises the "reproducer" together with the trumpet. The "reproducer" alone is incapable of generating such sound waves in air, and the violent air disturbances which are produced by its diaphragm, and which issue

through its mouth piece, are almost immediately dissipated in heat or in waves, which are not heard at any considerable distance if the horn be removed.

In the case of the "reproducer," all of the energy received from the record issues from its mouth as relatively violent disturbances, which are impressed upon a very small amount of free air, quite incapable of conducting such disturbances without transformation losses, and therefore the trumpet is resorted to to resist transformation into heat and to control the lateral form of the wave during a progressive spreading action, which is accompanied by a lessening of the violence of the disturbances, until a wave front of great area is attained having a movement appropriate to the sound conductivity of air. In this way it has been found practicable to transform a satisfactory part of the energy obtained from a moving record, into self-sustaining sound waves in air, but in every instance this method has been accompanied by distortions of the true recorded sounds in the reproducer, and more particularly in the trumpet, giving rise to those characteristic sounds, known as phonograph and horn sounds. These distortions of the true sounds are in a measure impressed upon the record in its making, but are more noticeable in the reproduction where a suppression of character and overtones, the loss of "timbre" in instruments and the voice, and the accentuation of notes of certain pitch, so change the recorded number that a faithful reproduction is not obtained.

It is an object of the present invention to regenerate the recorded sounds directly from the record, without the interposition of a confined body of air and without the employment of a restrictive transformer, such as a horn.

The "sound regenerator," in the case of the present invention, comprises a tympanum of relatively great area freely exposed to unconfined air, in which the sounds are to be propagated, and a mechanical transmission which faithfully transmits the vibrations produced by the record, to the tympanum, in such manner that the tympanum excites directly in the free air surrounding it sound waves of an intensity or amplitude substantially corresponding to the original recorded sound waves. In other words, the original sounds are directly regenerated by the vibrating

tympanum without the interposition of a restrictive or sound modifying transformer.

The invention consists in providing a tympanum of novel construction, which is capable of responding to the high frequency vibrations employed in the reproduction of sounds, and of imparting these vibrations to a large body of air; in providing a suitable mounting for this tympanum to permit it to exercise its function; and in providing a vibration transmission for receiving the vibratory movement from the record and transmitting this movement to the tympanum, without change of character and appreciable [fol. 14] loss of energy. The invention also comprehends certain combinations of parts and details of construction and location hereinafter particularly described and specifically pointed out in the appended claims.

I have illustrated in the accompanying drawings a sound reproducing machine embodying the several novel features of the invention as they may be employed in regenerating sounds from records made with either laterally or vertically sinuous grooves.

In the drawings,

Figure 1 is a plan view of the machine with the cover raised.

Fig. 2 is a vertical section on line 2—2 of Fig. 1, with cover and transmission arm raised.

Fig. 3 is a vertical section on line 3—3 of Fig. 1 with cover closed.

Fig. 4 is a vertical section on line 2—2 of Fig. 1 with cover closed and transmission arm in playing position.

Fig. 5 is a longitudinal section through the transmission arm on line 5—5 of Fig. 4.

Fig. 6 is a vertical longitudinal section through the transmission arm on line 6—6 of Fig. 5.

Fig. 7 is a vertical section on line 7—7 of Fig. 6.

Fig. 8 is an end view of the transmission arm.

Fig. 9 is a cross-section on line 9—9 of Fig. 5, and

Fig. 10 is a view similar to Fig. 8 of a modified arrangement for vertically sinuous records.

Referring to the drawings, the illustrated machine is mounted within a cabinet having a deck A upon which the motor and sound regenerator are supported. Side walls B downwardly extending from the edges of the deck A are

preferably apertured on all sides and provided with open work grilles C which afford substantially uninterrupted air paths for the sound waves from the interior of the cabinet in all directions laterally to the surrounding atmosphere. In the machine shown the cabinet is bottomless and provided with legs D at its four corners.

The motor may be of any suitable type, that shown having a frame E, spring drums e, winding gear e′, spiral drive gear e″, high pitch spiral table shaft e‴ and governor e⁗. The frame E of the motor is secured against the under side of the deck A depending therefrom and the table shaft projects upwardly through the deck A and carries the circular record table F above the deck. The motor frame E is preferably insulated from the deck A by rubber washers not shown.

The sound regenerator has a right-angled tubular support G, the vertical arm g of which has diametrically opposite conical depressions g′ which are engaged by pointed screws h′ which project inwardly from and are threaded through a ring h of larger internal diameter than the external diameter of the vertical arm g of the right-angled support G. The pointed screws h′ engage the depressions g′ forming a horizontal axis perpendicular to the horizontal arm g″ of the right-angled support G about which axis the arm g″ can swing in a vertical plane, the vertical arm g the while being incline- within the ring h. The ring h comprises the ring h proper and an annular retaining plate h″ screwed upon the lower face of the ring h, an annular groove at the junction of the ring h and plate h″ receiving the inner edge of a holding plate H in such manner that the ring h and the right-angled support G may be turned about a vertical axis in the holding plate H.

The holding plate H is clamped between two rubber or felt rings i, i′, the lower ring i′ resting upon the deck A. A ring I is placed upon the top of the upper ring i and screws i″ have their heads seated in the ring I and are screwed down into the deck A. The ring H and the rubber or felt rings i and i′ have large holes through which the screws i″ pass, so that these screws do not come into contact with the ring H and the right-angled support G is therefore

entirely insulated from the deck A by the rubber or felt rings. The vertical arm g of the right-angled support G extends downwardly through an aperture in the deck A at a point near the periphery of the record table F. A conical spider J shown as having three arms has its hub j fitted to the lower extremity of the vertical arm g of the right-angled support G, and is secured thereon by a set screw j'. To the ends of the arms of the spider J is secured by screws an annulus consisting of two ponderous rings K, K' of metal, these two rings being clamped together by screws k spaced at short intervals. Two of the three arms of the said spider are screwed tightly to the rings K, K' and the third is as tightly secured to said rings but by adjustable screws k', k'' arranged in such manner that the rings K, K' can be secured at varying distances from the foot of this third leg, there being sufficient spring in the spider legs to permit of an adjustment at this point of one-quarter of an inch or so, if desired. It will be seen that owing to the proximity of the mounting of the vertical arm g of the right-angled support G to the edge of the record table F, the spider J and the rings K, K' will underlie the record table and permit of a very compact arrangement of the working parts within the cabinet.

A tympanum L of light vibratile material has an annular plane peripheral portion l, the outer edge of which periph- [fol. 15] eral portion or supporting rim l is tightly gripped and rigidly supported between the ponderous rings K, K', and a central conical portion l' rising from the inner edge of the annular plane peripheral portion. If satisfactory regeneration of sounds from a record is to be had, the whole diameter of the tympanum, that is, the diameter of the aperture in the rings K, K', should exceed nine inches in order that the conditions shall be fulfilled which are required to regenerate the sound waves in the manner above described. The base of the central conical portion l' of the tympanum should exceed in area one-half the effective area of the entire tympanum, that is, the area of the aperture in the rings K, K'; or in other words, the diameter of the base of said conical portion should be at least eight-tenths of the diameter of the circular aperture in the supporting rings K, K'. The altitude of the conical portion l' of the tympanum should be at least one-quarter of the diameter

of its base. It is, of course, possible to make some variation from the approximate sizes given without materially altering the result, but if the tympanum is made as shown in the drawings, any great variation from these proportions will be found to affect the character of the reproduction. It is of vital importance that the tympanum be made of crisp, strong material, having considerable rigidity within itself, and it is also of vital importance that the tympanum as a whole be extremely light and have as little inertia as possible without a weakening effect. The tympanum is shown of conical form with a smooth surface, and this has been found to be very satisfactory. The conical shape is given the tympanum so that shocks or vibrations impressed upon the apex of the cone in a direction toward its base will move the whole cone bodily, the strains being imparted edgewise of the material and no wave motions being set up in the thin material of the cone. The curvature of the walls of the cone preclude the setting up of waves in the material and the intended object, a simultaneous movement of the whole conical portion of the tympanum, is attained. While I prefer to construct the tympanum in the form described and shown with a smooth surface, especially in view of the ease of construction, yet it is possible to form radial corrugations in the conical portion l′ and radial or concentric corrugations in the plane peripheral portion l and produce a light, stiff and very satisfactory article for the purpose. It is possible that when the tympanum is provided with corrugations as just suggested, some variation from the proportions above given may be found possible, and perhaps advisable, but such variations from the proportions given will not be great. The tympanum should preferably be constructed of a colloidal substance and should be from 3 to 20 thousandths of an inch in thickness according to the crispness or stiff character of the material used. Compressed fibrous material, such as hot pressed paper or fiber, has been found to act satisfactorily. It will be noted that the arms of the spider J incline downwardly to correspond with the concial shape of the tympanum L and that the apex of the conical portion of the tympanum is pointed upwardly toward the deck A of the cabinet, and that the concave side of the tympanum is open to the surrounding atmosphere through the open bottom of the cabinet, no obstructions be-

ing presented to the sound waves issuing from the concave surface of the tympanum.

A cap M is secured to the apex of the conical portion l′ of the tympanum L, and this cap should be of more rigid construction than the remainder of the tympanum and should preferably be three-eighths of an inch or more in diameter. I prefer to make the cap M of metal, extremely light but very rigid, and in the form of two cones m, m′ screwed tightly together upon opposite sides of the tympanum and gripping with their edges the material of the conical portion of the tympanum. In order that a tight and positive application of the cones forming the cap M to the conical portion of the tympanum may be had, it is preferable to form the cone m′ of lesser angle than the conical portion of the tympanum, and the cone m of greater angle than the conical portion of the tympanum in which case their edges will securely grip the tympanum material when they are secured together. The cap M is applied to the tympanum to receive the shocks which are to be applied to the tympanum as a whole, and convey them to sufficient of the material of the tympanum to insure the movement of the tympanum as a whole. This will be better understood when it is considered that if the shock were applied to paper or hard rubber at a single small point, the inertia of the tympanum as a whole would be sufficient to resist the attack and the material would be distorted or dented at that point, the effect of the shock upon the tympanum as a whole being entirely lost. The cap M being of hard material such as metal will resist the bending action and distribute the shock to so much of the surface of the material of the tympanum as is capable of successfully resisting the shock, and it will then be transmitted to the tympanum as a whole. The plane peripheral portion l of the tympanum maintains the place of the conical active portion of the tympanum and yields sufficiently to permit of the required motion of the conical portion, resisting, however, displacement of the conical [fol. 16] portion in just that degree necessary to maintain the form and neutral position of the active conical portion. Were the plane peripheral portion l of considerably greater width or markedly narrower than described, its function would be destroyed to a degree corresponding to the remoteness of the departure from the approximate proportion

given and the effective portion of the conical portion of the tympanum would be proportionately lessened.

In the tubular arm g″ of the transmission support G are located two ponderous members or weights N and N′. These members N and N′ are shown as insulated from the wall of the arm g″ by a tube o of insulating material, such as soft rubber or felt. One at least of the ponderous members N and N′ must be movable relatively to the other and therefore it cannot be rigidly secured to the support G, and the insulating material becomes necessary to avoid rattling. I preferably insulate both of the ponderous members or weights N, N′ from the wall of the transmission support G. Pins P projecting from the ponderous member N, and sliding in holes in the other ponderous member N′, act as guides and prevent disalinement and angular displacement of the movable ponderous member. Knife edge fulcra n and n′ are secured in and project from the ends of the ponderous members N and N′, and in the form of the device shown in Figs. 1 to 9 the fulcra n are arranged horizontally and the fulcra n′ are arranged vertically. A lever Q is mounted on the fulcra n′ and is capable of movement upon a vertical axis. A style holder q projects from the lever Q downwardly at an incline so that the point of a style q′ held in the style holder is considerably removed from the axis of the lever Q and movement given the style q′ by the record will effect an oscillation of the lever Q about its vertical axis upon the fulcra n. The lever Q has arms q″ and q‴ projecting from opposite sides thereof, the arm q″ being near the top of the lever Q and the arm q‴ being near the bottom of said lever. The reason for this arrangement of the arms upon the lever will presently appear.

A lever R is mounted upon the fulcra n and oscillates upon a horizontal axis. This lever has arms r and r′ extending upwardly and downwardly from its opposite sides, the arm r projecting from a point near one end of the lever R, and the arms r′ projecting from a point near the other end of the lever R. It will now be seen that a point upon the arm r of the lever R is opposite a similar point on the arm q″ of the lever Q and these two points are connected by rod link S. It will also be seen that a point upon the arm r′ of the lever R is opposite a point upon the arm q‴ of the lever Q and these two points are connected by a rod link S′.

The rod links S and S′ have eye-ends arranged in planes removed 90° from one another, and these eye-ends s are engaged by pivot screws s′ upon the arms of the levers Q and R. A parallelogram is formed by the levers Q and R and the rod links S and S′, and in the form just described, which is adapted for a laterally sinuous groove in the record, oscillation of the lever Q about a vertical axis will produce like oscillations of the lever R about a horizontal axis. Springs T preferably mounted upon the pins P press the ponderous members N and N′ apart forcing the knife edge fulcra n and n′ tightly against the levers R and Q, and put the parallelogram of levers and links under tension, precluding any rattle or looseness of the levers upon the fulcra or of the eye-ends of the links upon their pivot screws, and as the movable ponderous member of the combination is insulated from the transmission support G, no rattle or displacement of the parts can take place when the record groove oscillates the lever Q, but such oscillation will be faithfully transmitted to the lever R. The ponderous members N and N′ have clearance holes s″ for the rod links S and S′.

An arm U projects from the central portion of the lever R and to its end is rigidly secured a rod V which extends downwardly through the interior of the arm g of the transmission support G, its lower end being rigidly secured to the cap M of the tympanum. The rod V is nicked or thinned at v close to the arm U of the lever R to permit of a slight springing action which compensates for the very slight angular motion of the arm U when the lever R is oscillated. It will now be seen that the oscillation of the lever R about its horizontal axis imparted to it from the lever Q, will effect an endwise vibration of the rod V which is directly impressed upon the tympanum L. A cap W closes the opening at the angle of the transmission support G and the removal of this cap gives access to the working parts of the rear end of the transmission.

It will be noted that the distance between the point of the style q′ and the axis of the lever Q is greater than the length of the arm U which projects from the center of the lever R and to which the rod V is connected. By reason of this fact, and of the fact that the levers Q and R, and the rod links S, S′ form a parallelogram, the length of vibration of the

tympanum is relatively much less than that of the style, and the tympanum thus offers little resistance to the movement of the style, thereby greatly reducing the wear on the record. To compensate for this small movement of the tympanum, its large area enables it to move a large body of air, so as to obtain sound waves of large volume and great carrying power.

When a vertically sinuous record is employed the lever Q [fol. 17] is mounted to oscillate about a horizontal axis, as shown in Fig. 10, no change in the lever R being required.

Having thus described my invention, what I claim and desire to secure by Letters Patent, is:—

1. In a machine for directly regenerating sound from a record of the same, a vibratile conical tympanum of large area rigidly supported at its periphery and freely exposed to unconfined air, and a mechanical transmission through which the vibrations produced by the record are transmitted to the tympanum, the tympanum being of sufficient area to impart to the surrounding free air, when the tympanum is so vibrated, sound waves substantially corresponding in intensity to the recorded sound waves: substantially as described.

2. In a machine for directly regenerating sound from a record of the same, a vibratile conical tympanum of large area rigidly supported at its periphery and freely exposed to unconfined air, a mechanical transmission through which the vibrations produced by the record are transmitted to the tympanum, the tympanum being of sufficient area to impart to the surrounding free air, when the tympanum is so vibrated, sound waves substantially corresponding in intensity to the recorded sound waves, and an open-work cabinet inclosing the tympanum but affording substantially free access of the surrounding air thereto; substantially as described.

3. In a direct sound regenerating machine, the combination of a record holder, a transmission support mounted to swing over said record holder, and a tympanum carried by said support and extending under said record holder; substantially as described.

4. In a direct sound regenerating machine, the combination with a record holder, of a transmission support mounted to swing about vertical and horizontal axes, said support having an arm extended to move above and across

said record holder and adapted to carry a stylus, the support having a second arm having a free end, and a tympanum carried at the free end of said second arm with its axis at an angle to said first arm; substantially as described.

5. In a sound regenerating machine, a vibration transmission comprising two ponderous members, fulcra carried by said members, an articulate parallelogram having opposite sides mounted on said fulcra and means exerting pressure upon said ponderous members to place said parallelogram under tension; substantially as described.

6. In a sound regenerating machine, a vibration transmission comprising two ponderous members, fulcra carried by said members, an articulate parallelogram of non-extensible links and non-flexible levers, the levers of said parallelogram being mounted on said fulcra, and means exerting pressure upon said ponderous members to place said parallelogram under tension; substantiallly as described.

7. In a machine for directly regenerating sound from a record of the same, a tympanum support having a circular aperture, a light vibratile tympanum of long area having its outer edge rigidly mounted in said support, said tympanum being shaped to provide an annular sustaining rim adjacent said support, and a conical portion springing from the inner edge of said annular rim, a cap of non-vibratile material rigidly secured to the apex of said conical portion of said tympanum, and a mechanical transmission through which the vibrations produced by the record are transmitted to the tympanum, the tympanum being of sufficient area to impart to the surrounding free air, when the tympanum is so vibrated, sound waves substantially corresponding in intensity to the recorded sound waves; substantially as described.

8. In a machine for directly regenerating sound from a record of the same, a ponderous tympanum support having a circular aperture, a light tympanum of long area having its outer edge rigidly mounted upon said support in said aperture, said tympanum having a central conical portion, the base of which exceeds in area one half the effective area of the said tympanum and a mechanical transmission through which the vibrations produced by the record are transmitted to the tympanum, the tympanum being of sufficient area to impart to the surrounding free air, when the

tympanum is so vibrated, sound waves substantially corresponding in intensity to the recorded sound waves; substantially as described.

9. In a machine for directly regenerating sound from a record of the same, a ponderous tympanum support having a circular aperture, a light vibratile tympanum exceeding nine inches in diameter, having its outer edge rigidly mounted on said support, said tympanum being shaped to provide an annular rim adjacent said support, and a conical portion springing from the inner edge of said annular rim, a cap of non-vibratile material rigidly secured to the apex of said conical portion of said tympanum, and a mechanical transmission through which the vibrations produced by the record are transmitted to the tympanum, whereby the tympanum imparts to the surrounding free air sound waves substantially corresponding in intensity to the recorded sound waves; substantially as described.

10. In a machine for directly regenerating sound from a record of the same, a ponderous tympanum support having [fol. 18] a circular aperture exceeding nine inches in diameter, a light vibratile tympanum mounted in said aperture and having its outer edge rigidly secured upon said support, said tympanum being shaped to provide an annular rim adjacent said support, and a conical portion springing from the inner edge of said annular rim, the diameter of the base of said conical portion being not less than eight-tenths of the diameter of the said circular aperture in said support, a cap of non-vibratile material rigidly secured to the apex of said conical portion of said tympanum, and a mechanical transmission through which the vibrations produced by the record are transmitted to the tympanum, the tympanum being of sufficient area to impart to the surrounding free air, when the tympanum is so vibrated, sound waves substantially corresponding in intensity to the recorded sound waves; substantially as described.

11. In a machine for directly regenerating sound from a record of the same, a ponderous tympanum support having a circular aperture, a light vibratile tympanum of long area mounted in said aperture, and having its outer edge rigidly secured to said support, said tympanum being shaped to provide an annular rim adjacent said support, the outer diameter of said rim exceeding nine inches, and a conical portion springing from the inner edge of said annular rim, the

altitude of said conical portion being substantially one fourth of the diameter of its base, a cap of non-vibratile material rigidly secured to the apex of said conical portion of said tympanum, and a mechanical transmission through which the vibrations produced by the record are transmitted to the tympanum, the tympanum being of sufficient area to impart to the surrounding free air, when the tympanum is so vibrated, sound waves substantially corresponding in intensity to the recorded sound waves; substantially as described.

12. In a machine for directly regenerating sound from a record of the same, a ponderous tympanum support having a circular aperture exceeding nine inches in diameter, a light vibratile tympanum mounted in said aperture and having its outer edge rigidly secured to said support, said tympanum being shaped to provide an annular rim adjacent said support, and a conical portion springing from the inner edge of said annular rim, the diameter of the base of said conical portion being not less than eight-tenths of the diameter of said circular aperture in said support, and the altitude of said conical portion being substantially one quarter of the diameter of its base, a cap of non-vibratile material rigidly secured to the apex of said conical portion of said tympanum, and a mechanical transmission through which the vibrations produced by the record are transmitted to the tympanum, whereby the tympanum imparts to the surrounding free air sound waves substantially corresponding in intensity to the recorded sound waves; substantially as described.

13. In a sound regenerating machine, a vibration transmission comprising two ponderous members, fulcra carried by said members, an articulate parallelogram of links and levers, the levers of said parallelogram mounted upon said fulcra, pressure exerting means acting between said members and tending through said fulcra to hold said parallelogram under tension, and a style holder carried by one of said levers; substantially as described.

14. In a sound regenerating machine, a vibration transmission comprising two ponderous members, guides for maintaining the relative positions of said members, fulcra carried by said members, an articulate parallelogram of

links and levers, the levers of said parallelogram mounted upon said fulcra, pressure exerting means acting between said members and tending through said fulcra to hold said parallelogram under tension, and a style holder carried by one of said levers; substantially as described.

15. In a sound regenerating machine, a vibration transmission comprising two ponderous members, guides for maintaining the relative positions of said members, fulcra carried by said members, an articulate parallelogram of links and levers, the levers of said parallelogram mounted upon said fulcra, pressure exerting means acting between said members and tending through said fulcra to hold said parallelogram under tension, and a style holder carried by one of said levers; substantially as described.

16. In a sound regenerating machine, a vibration transmission comprising two ponderous members, a vertical fulcrum on one of said members, a horizontal fulcrum on the other of said members, an articulate parallelogram of links and levers, the levers of said parallelogram mounted upon said fulcra, and pressure exerting means acting between said members and tending through said fulcra to hold said parallelogram under tension; substantially as described.

17. In a sound regenerating machine, a vibration transmission comprising two ponderous members, fulcra carried by said members, an articulate parallelogram of links and levers, the levers of said parallelogram mounted upon said fulcra, pressure exerting means acting between said members and tending through said fulcra to hold said parallelogram under tension, a style-holder carried by one of said levers, a direct sound regenerating tympanum connected to another of said levers and a pivoted support for said transmission and said tympanum; substantially as described.

[fol. 19] 18. In a sound regenerating machine, a vibration transmission comprising a support, two ponderous members carried by said support, one of said members being movable upon said support, insulating material between said movable member and said support, fulcra carried by said members, an articulate parallelogram of links and levers, said levers being mounted on said fulcra and pressure exerting means acting between said members and tending

through said fulcra to hold said parallelogram under tension; substantially as described.

19. In a direct sound regenerating machine, the combination of a bottomless cabinet having apertures on all sides and a horizontal partition therein, a record holder mounted upon and above said partition, a motor for driving said record holder, a right angled transmission support mounted to swing upon horizontal and vertical axis upon said partition adjacent the periphery of said record holder, one arm of said support adapted to be swung over said record holder, and the other arm of said support extending downwardly through said partition, a vibration transmission mounted within and insulated from said transmission support and comprising two ponderous members carrying fulcra, a parallelogram of links and levers, said levers mounted upon said fulcra, pressure exerting means acting between said members and tending through said fulcra to hold said parallelogram under tension, a style-holder carried by one of said levers at the outer end of said transmission support, a spider mounted upon said transmission support below said partition, a ponderous tympanum support carried by said spider, a direct sound regenerating tympanum mounted upon said ponderous tympanum support, said tympanum being of light vibratile material and having a conical form throughout the greater part of its area and a positive connection between the apex of the conical portion of said tympanum and the inner end of the parallelogram of the said vibration transmission; substantially as described.

20. In a sound regenerating machine, a tympanum, a vibration transmission tensioned in the direction of its vibration independently of the tympanum and connected therewith, and a style holder connected with said transmission.

21. In a sound regenerating machine, an untensioned tympanum, a vibration transmission tensioned in the direction of its vibration and connected with said tympanum, and a style holder connected with said transmission.

22. In a sound regenerating machine, a tympanum, an oscillatory transmission member connected therewith, a style holder for oscillating the transmission member, and means independent of the tympanum for tensioning the

transmission member in the direction of its oscillatory movement.

23. In a sound regenerating machine, a tympanum, an oscillatory transmission member connected therewith, a style holder for oscillating said member, and means independent of the tympanum for yieldingly imparting a tension to said member in the direction of its oscillatory movement.

24. In a sound regenerating machine, an untensioned tympanum, a transmission member connected therewith and adapted for oscillation, a style holder for oscillating said member, and means for imparting a tension to said member in the direction of its oscillatory movement.

25. In a sound regenerating machine, a style holder, a tympanum having a rigid vibratory portion, and a tensioned transmission connecting the style holder with said rigid portion, the tension of said transmission being in the direction of its vibration and independent of the tympanum.

26. In a sound regenerating machine, a style, a tympanum, and tensioned transmission means connecting the style and tympanum and having means for imparting vibrations to the tympanum having no greater length than the vibrations of the style, the tension of said transmission being in the direction of its vibrations and independent of the tympanum.

27. In a sound regenerating machine, a tympanum having a vibratile area of sufficient size to effect, without amplification, the regeneration from a record of sound waves of relatively large volume and carrying power, and tensioned vibration transmitting means connected to the tympanum and adapted to be actuated by a style, the tension of the transmission being in the direction of its vibration and not extending to the tympanum.

28. In a sound regenerating machine, a tensioned vibration transmission, a styleholder upon one end of said transmission and an untensioned tympanum connected with the opposite end of said transmission, the tension of the transmission being in the direction of its vibration; substantially as described.

29. In a sound-regenerating machine, a vibratile conical tympanum of large area rigidly supported at its periphery and freely exposed to unconfined air; a sound-vibrated element, and vibration transmission means connecting said element and said tympanum and arranged to impart to the tympanum vibrations which are relatively much shorter than the vibrations imparted to the said element.

30. In a sound-regenerating machine, a vibratile conical tympanum rigidly supported at its periphery and freely ex- [fol. 20] posed to unconfined air, a sound-vibrated element, and vibration transmission means connecting said element and said tympanum arranged to impart to the tympanum vibrations which are relatively much shorter than the vibrations imparted to the said element; the tympanum having an area sufficiently large to effect, without amplification, sound waves of large volume and carrying power.

31. In a sound-regenerating machine, a vibratile conical tympanum of large area, rigidly supported at its periphery and freely exposed to unconfined air, a sound-vibrated element, and tensioned transmission means connecting said element and said tympanum and arranged to impart to the tympanum vibrations which are relatively much shorter than the vibrations imparted to the record end of the style.

In testimony whereof I affix my signature, in presence of two witnesses.

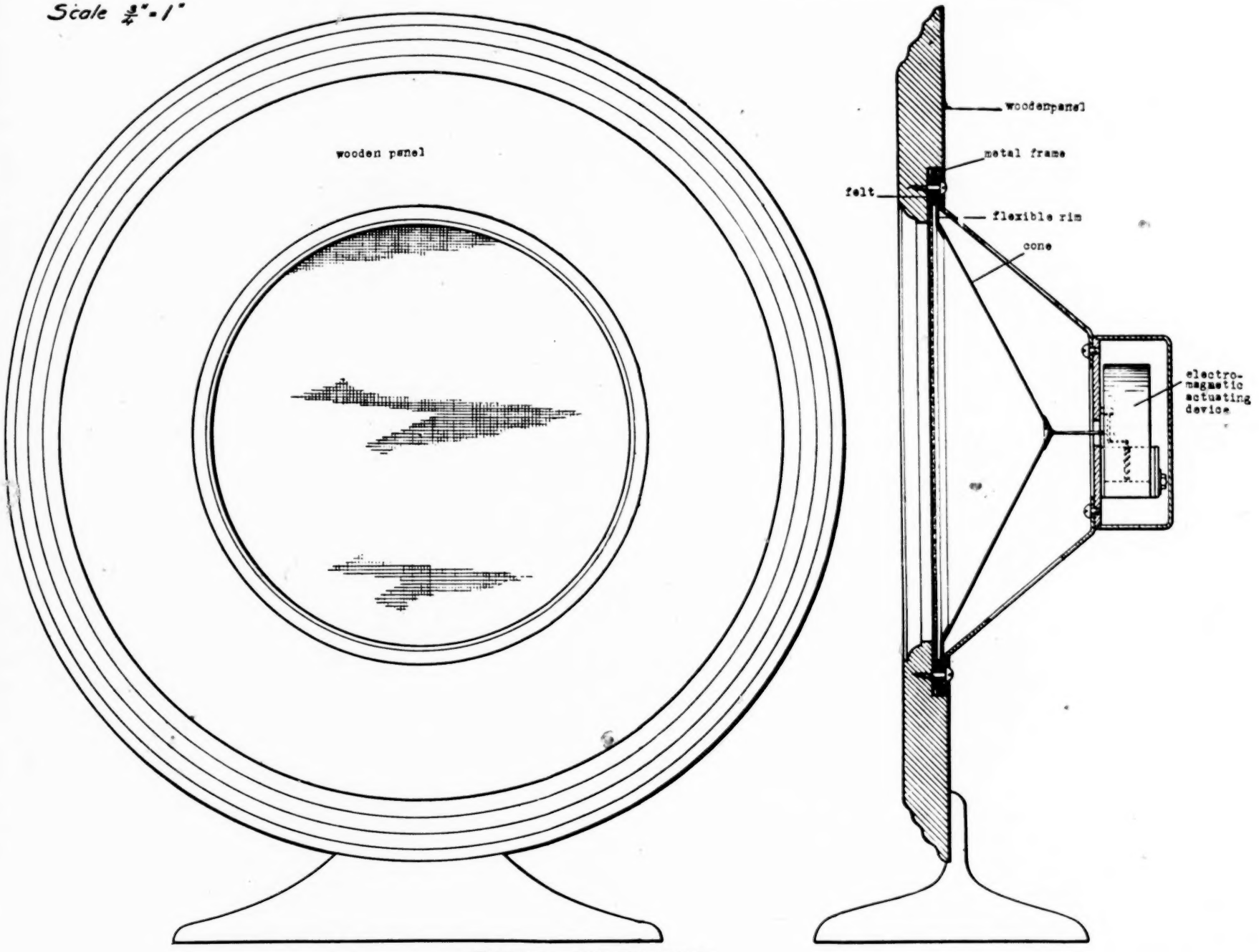
Marcus C. Hopkins.

Witnesses: M. A. Bill, Leon W. Rosenthal.

Corrections in Letters Patent No. 1,271,527

It is hereby certified that in Letters Patent No. 1,271,527, granted July 2, 1918, upon the application of Marcus C. Hopkins, of Jersey City, New Jersey, for an improvement in "Sound-Regenerating Machines," errors appear in the printed specification requiring correction as follows: Page 1, line 25, for the word "magaphone" read megaphone; page 5, lines 75 and 95, claims 7 and 8, and page 6, line 25, claim 11, for the word "long" read large; and that the said Letters Patent should be read with these corrections therein

PLAINTIFF'S EXHIBIT No. 4.



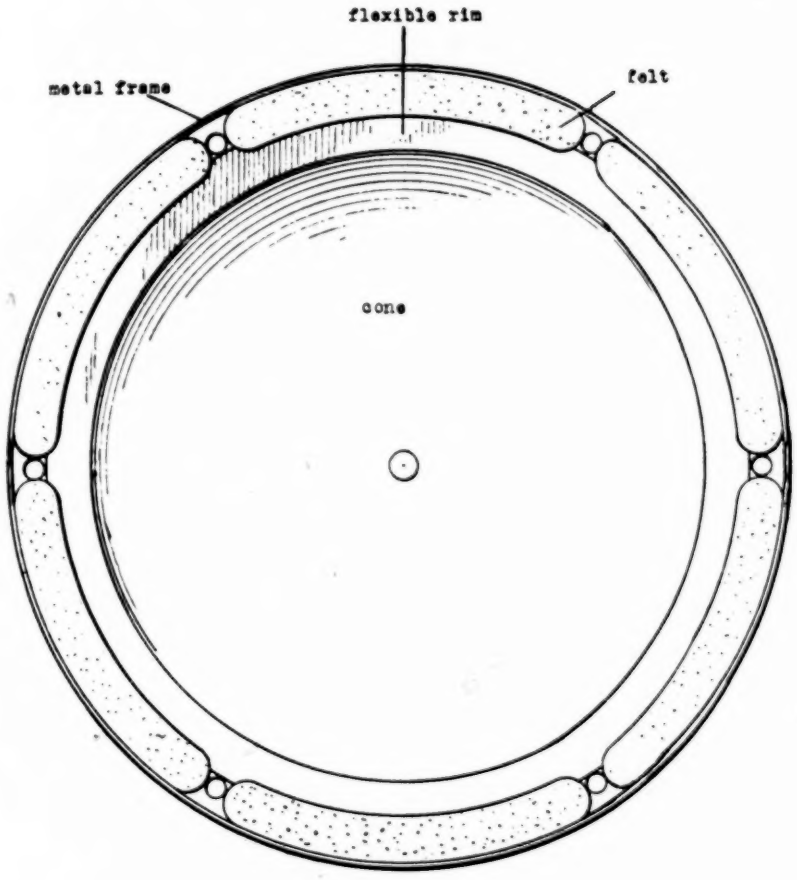
ROLA SPEAKER

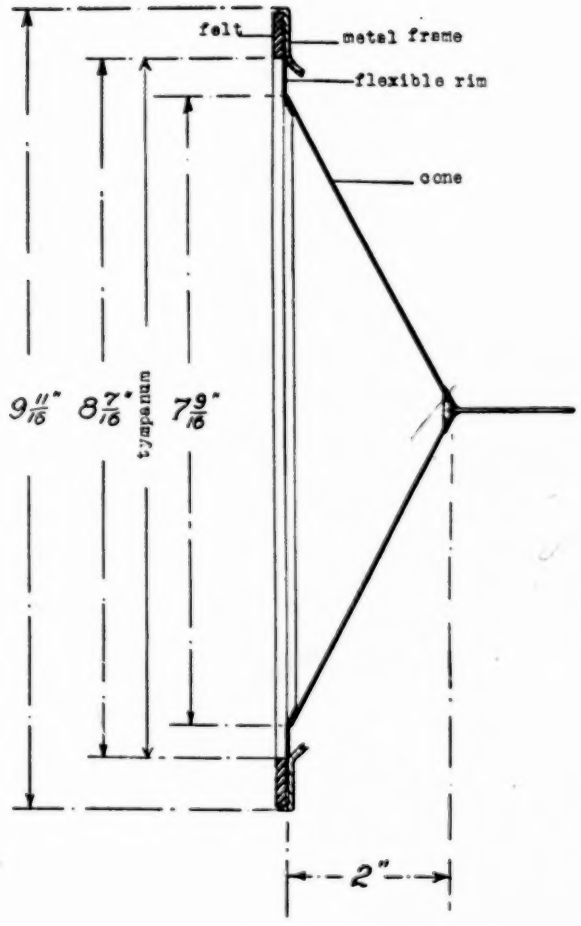
Front view and sectional view of complete speaker

[Endorsed]: No. 1726. United States District Court. Lektophone vs. Rola. Plfts. Exhibit No. 4. Filed 5/10/28. Walter B. Maling, Clerk. By A. C. Aurich, Deputy Clerk.

No. 5712. United States Circuit Court of Appeals for the Ninth Circuit. Filed Feb. 5, 1929. Paul P. O'Brien, Clerk.

Scale $\frac{3}{4}$" - 1"





Area of tympanum = 55.95 sq. in.
Area of base of cone = 44.90 sq in.

ROLA SPEAKER

Front view and sectional view of tympanum and portion of supporting frame.

that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 28th day of September, A. D., 1920.

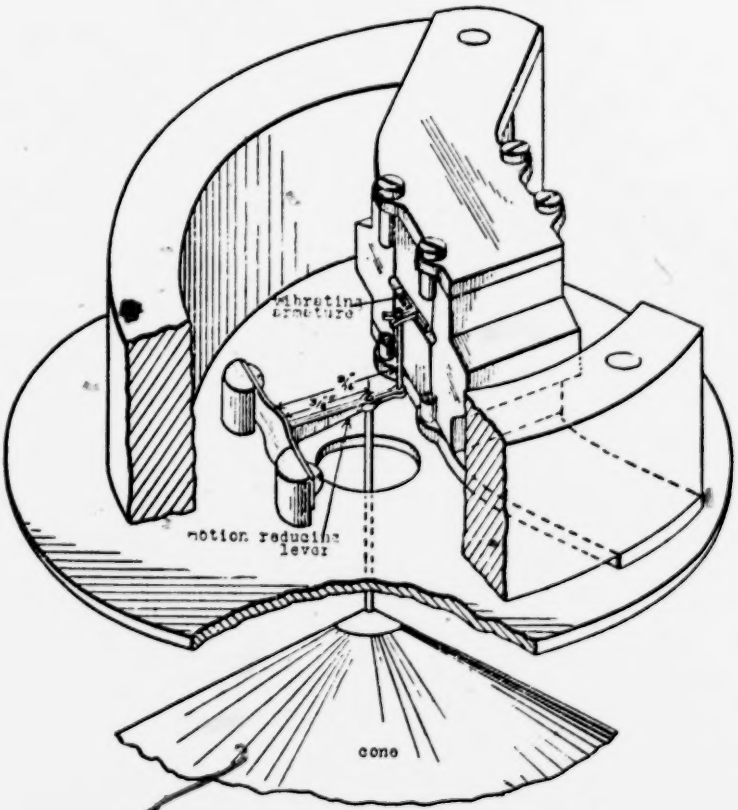
M. H. Coulston, Acting Commissioner of Patents.

(Seal.)

Cl. 274—16.

(Here follow drawings, side folios 21 & 22, 23 & 24)

[fol. 25] PLAINTIFF'S EXHIBIT No. 5



PERSPECTIVE VIEW OF ELECTRO-MAGNETIC ACTUATING DEVICE OF ROLA SPEAKER SHOWING LEVER MECHANISM FROM ARMATURE TO CONE.

[Endorsed:] No. 1726. United States District Court. Lektophone vs. Rola. Plft's. Exhibit No. 5. Filed 5/10/28.

Walter B. Maling, Clerk. By A. C. Aurich, Deputy Clerk.

No. 5712. United States Circuit Court of Appeals for the Ninth Circuit. Filed Feb. 5, 1929. Paul P. O'Brien, Clerk.

[fol. 26] PLAINTIFF'S EXHIBIT NO. 6

2—390

Department of Commerce, Patent Office

To all persons to whom these presents shall come, Greeting:

This is to certify that the annexed is a true copy from the records of this office of the File Wrapper, Contents and Drawing, in the matter of the Letters Patent of Marcus C. Hopkins, Assignor by Mesne Assignments to Lektophone Corporation, Number 1,271,529, Granted July 2, 1918, for Improvement in Acoustic Devices.

In testimony whereof I have hereunto set my hand and caused the seal of the Patent Office to be affixed, at the City of Washington, this Fourteenth day of November, in the year of our Lord, one thousand nine hundred and twenty-five and of the Independence of the United States of America the one hundred and fiftieth.

Thomas E. Robertson, Commissioner of Patents.

Attest: D. E. Wilson, Chief of Division. (Seal.)

[fol. 27] 1918. WB.

Number (Series of 1915), (Ex'r's Book) 108 76.
229,014

Div. 23. Patent No. 1271529.

Name: Marcus C. Hopkins, Assor. by mesne Assigts. to Lektophone Corporation of New York, N. Y., a Corp. of Delaware.

Of New York.

County of ——,

State of New York.

Invention: Acoustic Devices.

	Original	Renewed	
Parts of application filed	Petition—	April 12, 1918	, 191-
	Affidavit—	" " , 1918	, 191-
	Specification—	" " , 1918	, 191-
	Drawing—	" " , 1918	, 191-
	Photo Copy—	, 1918	, 191-
	First Fee Cash $15	Apr. 17, 1918	, 191-
	" " Cert.	, 191-	, 191-
	Appl. filed complete—	April 17, 1918	, 191-

Examined and Passed for Issue,
Apr. 22, 1918 , 191-
W. D. Groesbeck, Exr. Div. 23 Exr. Div.
Notice of Allowance April 29, 1918 , 191-
By Commissioner.
Final Fee Cash $20 June 3, 1918 , 191-
" " Cert. , 191- , 191-
Patented July 2, 191-
Attorneys, Pennie, Davis, Marvin & Edmonds, 35 Nassau St., New York, N. Y.
Associate Attorney

[On left margin:] 7158—July 14, 1913. Division of App., No. Renewal #224048, filed renewed Mar. 22, 1918.
[fol. 28] (No. of Claims Allowed—8.) Print Claims—1-4 in O. G. (Cl. 181-31.)
Title as Allowed—Acoustic Devices.
2—7

Department of the Interior, United States Patent Office, Washington

Div. 23

$15—Recd. Apr. 17, 1918. C. C. U. S. Pat. Office.

The Commissioner of Patents:

Sir: Please apply filing fee of $15 herewith application of Marcus C. Hopkins, Sound Regenerating Machines—Filed Apr. 12/18.

Pennie, Davis, Marvin & Edmonds.

11—520

(Give full address:) 35 Nassau St., New York.
Cost: $——.
Received: $——.
Delivered: —— —, 191-.

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11860

Mail Room, Apr. 12, 1918, U. S. Patent Office

PETITION

To the Commissioner of Patents:

Your petitioner, Marcus C. Hopkins, a citizen of the [fol. 29] United States, residing in the borough of Manhattan, city, county and State of New York, whose Post Office address is No. 35 Nassau Street, New York City, N. Y., prays that Letters Patent may be granted to him for improvements in acoustic devices, as set forth in the annexed specification.

And he hereby appoints John C. Pennie, William H. Davis, Arba B. Marvin and Dean S. Edmonds (constituting the firm of Pennie, Davis, Marvin & Edmonds, 35 Nassau Street, New York, Registration No. 10839), and each of them, his Attorneys, with full power of substitution and revocation, to prosecute this application, to make alterations and amendments therein, to sign the drawings, to receive the patent, and to transact all business in the Patent Office connected therewith.

Marcus C. Hopkins.

SPECIFICATION

To all whom it may concern:

Be it known that I, Marcus C. Hopkins, a citizen of the United States, residing in the borough of Manhattan, city, county, and State of New York, have invented certain new and useful Improvements in Acoustic Devices; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others

skilled in the art to which it appertains to make and use the same.

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[fol. 30] 11861

This invention relates to instruments which reproduce sounds; and is particularly directed to the attainment of a direct propagation, in free air, from a record or equivalent element subjected to the action of the original sound waves or vibrations, of self-sustaining sound waves substantially corresponding in intensity and amplitude, as well as in pitch or timbre, to the said original sound waves, as distinguished from an initial generation of violent air disturbances in a confined space, and a subsequent transformation of such disturbance into self-sustaining sound waves by means of a megaphone, horn or other amplifier.

In the case of a talking machine, the device employed to propagate the regenerated sound waves in air comprises the reproducer or sound-box and the horn; but the reproducer alone is incapable of propagating sound waves of the character above stated because of the fact that the air disturbances which are produced by its diaphragm and which issue through its mouth-piece are almost immediately dissipated in heat or in waves which are not heard at any considerable distance if the horn be removed. Consequently, it is usual in all instruments of the class indicated to employ an amplifier of some sort to resist transformation into heat and to control the lateral form of the wave during a progressive spreading action which is accompanied by a lessening of the violence of the disturbance until a wave front of great area is attained having a movement appropriate to the sound conductivity of air. In this [fol. 31] way, it has been found practicable to transform a satisfactory part of the energy, obtained from a moving record, into self-sustaining

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sound waves in air; but in every instance such method has been accompanied by distortions of the true recorded sounds in the reproducer, and more patricularly in the

horn or amplifier, giving rise to those characteristic sounds known as phonograph and horn sounds. These distortions of the true sounds are in a measure impressed upon the record in its making, but are more noticeable in the reproduction, where a suppression of character and overtones, the loss of timbre in instruments and the voice, and the accentuation of notes of certain pitch, so change the recorded number that a faithful reproduction is not obtained.

It is the object of the present invention to regenerate the original sounds directly from the record or other element subjected to the action of such sounds, without interposition of a confined body of air and without the employment of a restrictive transformer, such as a horn. According to the invention, the sound regenerator comprises a tympanum of relatively great area freely exposed to unconfined air, in which the sounds are to be propagated; the vibrations produced by the record or its equivalent,—that is, the element on which the original sounds or sound waves are recorded, or which is otherwise subjected to the vibrating action of said sounds or sound waves and may, therefore, be termed the "sound-vibrated" element—being faith- [fol. 32] fully transmitted to the tympanum in such manner that the latter excites directly in the free air surrounding it, sound waves of an intensity and amplitude substantially corresponding to the original sound waves. In other words, the original sounds are directly regenerated by the vibrating tympanum without the interposition of a restrictive or sound-modifying transformer.

The invention consists, briefly, in the provision of a tympanum of novel construction, which is capable of responding to the high frequency vibrations employed in the reproduction of sounds, and of imparting these vibrations to a large body of air; and it is to be considered as a division of the invention shown and described in my prior application, renewed March 22, 1918, No. 224,048.

The accompanying drawing illustrates the improved tympanum incorporated in a sound-reproducing machine of the kind disclosed in said application, the single figure being a

vertical sectional view taken transversely through the machine. Reference may be had to this application for a disclosure of the complete machine; and in order to facilitate and understanding of the present invention as compared with such disclosure, the same reference characters will be employed as in the said earlier application to indicate corresponding parts.

The machine represented in said drawing is mounted within a cabinet having a deck A, upon which the motor [fol. 33] (not shown) and the sound regenerator are mounted. Side walls B extend downwardly from the edges of the deck A, and are preferably apertured on all sides and provided with open-work grills C, which afford substantially uninterrupted air paths for the sound waves from the interior of the cabinet in all directions laterally to the surrounding atmosphere. In the machine shown, the cabinet is bottomless and provided with legs D at its four corners. The motor may be of any suitable type, and is connected to drive the shaft of the turn-table F through the intermediary of gearing, as is usual, said shaft projecting up-

wardly through the deck A. The turn-table carries the record F', which in this instance is the element directly acted upon by the original sound vibrations which are to be subsequently regenerated or reproduced; that is to say, the record, in the present construction, is the "sound-vibrated" element.

The sound regenerator has a right-angled tubular support G, the vertical arm *g* of which is engaged at diametrically—opposite points by bearing screws *h'*, which project inwardly from and are carried by a ring *h* of larger diameter than the said arm *g*, as described in said prior application. The screws *h'* form a horizontal axis perpendicular to the horizontal arm *g''* of the right-angled support G, about which axis the arm *g''* can swirng in a vertical plane, the vertical arm *g* the while being inclined within the ring *h*. The latter forms part of an annular bearing device se- [fol. 34] cured upon the deck A, the open central portion of which device alines with an opening of larger diameter

in said deck, and the said vertical arm g of the support G extends downwardly through these openings and has its lower extremity fitted in the hub j of a conical spider J and fastened to the same by a set screw j'.

The spider J in the present construction has three arms, only two of which appear, however; and to the lower ends of these arms there is secured by screws an annulus consisting of two ponderous rings K, K′ of metal, which are clamped together by screws k spaced at short intervals. Two of the three arms of the said spider are screwed tightly to the rings K, K′, and the third is so arranged that the

rings K, K′ can be secured at varying distances from the foot of this third arm, there being sufficient spring in the spider arms to permit of an adjustment at this point of one-quarter of an inch or so, if desired. This detail is illustrated in my earlier case, and for that reason is not represented in the present case.

The tympanum L, which forms the subject of the present case, is constructed of light, vibratile material and has an annular plane peripheral portion or supporting rim l, the outer edge of which is tightly gripped and rigidly supported between the rings K, K′, and a central conical portion l' rising from the inner edge of the said rim l. If satisfactory regeneration of sounds from a record or other sound-vibrated element is to be had, the whole diameter of the [fol. 35] tympanum, that is, the diameter of the aperture in the rings K, K′ should exceed nine inches in order that the conditions required to regenerate the sound waves in the manner above described shall be fulfilled. The base of the central conical portion l' should exceed in area one-half of the effective area of the entire tympanum, that is, the area of the aperture in the rings K, K′; or in other words, the diameter of the base of said conical portion should be at least eight-tenths of the diameter of the said aperture. The altitude of the conical portion l' should be at least one-quarter of the diameter of its base.

It is, of course, possible to make some variation from the approximate sizes given without materially altering the result; but if the tympanum is constructed as shown in the drawing, any great variation from these proportions will be found to affect the character of the reproduction. It is

of vital importance that the tympanum be made of crisp, strong material, having considerable rigidity within itself, and it is also of vital importance that the tympanum as a whole be extremely light and have as little inertia as possible without a weakening effect. The tympanum is shown of conical form with a smooth surface, and this has been found to be very satisfactory. The conical shape is given the tympanum so that shocks or vibrations impressed upon the apex of the cone in a direction towards its base will [fol. 36] move the whole cone bodily, the strains being imparted edgewise of the material and no wave motions being set up in the thin material of the cone. The curvature of the walls of the cone precludes the setting up of waves in the material; and the intended object, a simultaneous movement of the whole conical portion of the tympanum, thus
is/attained. While I prefer to construct the tympanum in the form described and shown with a smooth surface, especially in view of the ease of construction, yet it is possible to form radial or concentric corrugations in the plane peripheral portion *l* and produce a light, stiff and very satisfactory article for the purpose. It is conceivable, too, that when the tympanum is provided with corrugations as just suggested, some variation from the proportions above given may be made; but such variations will not be great. The tympanum should preferably be constructed of a collodial substance, and should be from 3 to 20 thousandths of an nich in thickness according to the crispness or stiff character of the material used. Compressed fibrous material, such as hot pressed paper or fibre, has been found to act satisfactorily.

It will be noted that in the construction illustrated, the

arms of the spider J incline downwardly to correspond with the conical shape of the tympanum L, the apex of the conical portion of the tympanum pointing upwardly toward the deck A of the cabinet, and, also, that the concave side of the said tympanum is open to the surrounding atmosphere [fol. 37] through the open bottom of the cabinet, no obstructions being presented to the sound waves issuing from the concave surface of the tympanum.

A cap M is secured to the apex of the conical portion l of the tympanum, and this cap should be of more rigid construction than the remainder of the tympanum and should preferably be three-eights of an inch or more in diameter. I prefer to make the cap M of metal, extremely light but very rigid, and in the form of two cones m, m′ screwed tightly together upon opposite sides of the tympanum so as to grip the material thereof with their edges. In order that a tight and positive application of the cones forming the cap M to the conical portion of the tympanum may be had, it is preferable to form the inner cone m′, of lesser angle, and the outer cone m of greater angle than the said conical portion, in which case their edges will securely grip the tympanum material when they are fastened together.

The vibrations or sound waves originally imparted to the record or its equivalent may be transmitted therefrom to the tympanum to vibrate the same in the manner and by means of the mechanism shown and described in my aforesaid application above identified, or by means of some other approved transmission means or mechanism, as will be understood. In any event, such means or mechanism forms no part of the present case, however, and for that

[fol. 38] reason requires no extended dliselosure. It is believed sufficient to state, therefore, that in the arrangement illustrated the mechanism in question is located within the horizontal arm g″ of the support G, and is connected at its

forward end with the stylus holder q, the other end of said mechanism having connected to it a vertical rod V, which extends downwardly through the interior of the vertical arm g of the support and is rigidly secured to the cap M of the tympanum. In consequence, the vibrations of the stylus q′ mounted in said holder and produced in the usual way by the phonic lines on the record, will be transmitted from the stylus through the transmission mechanism to the rod V, which will be vibrated endwise, the endwise vibrations of said rod being directly impressed upon the tympanum L.

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I claim:

1. An acoustic device, comprising a tympanum rigidly supported at its periphery and having a free area exceeding nine inches in diameter and a conical portion A^1. $\wedge$ [substantially]* eight-tenths of the diameter of A^1 said free area.

2. An acoustic device, comprising a tympanum rigidly supported at its periphery and having a free area exceeding nine inches in diameter and a conical " portion $\underset{A^1}{\wedge}$ [substantially]* eight-tenths of the diameter of said free area, said conical portion being rigid in the direction of the axis of the tympanum.

[fol. 39] 3. An acoustic device, comprising a tympanum rigidly supported at its periphery and having a free area exceeding nine inches in diameter and a " conical portion $\underset{A^1}{\wedge}$ [substantially]* eight-tenths of the diameter of said free area, the altitude of said conical portion being substantially one-quarter of the diameter of its base.

4. An acoustic device, comprising a tympanum support having a circular aperture, and a light tympanum freely exposed to unconfined air and having its outer edge rigidly mounted on said support in said aperture; said tympanum

[*Words and figures enclosed in brackets erased in copy.]

having a central conical portion, the base of which exceeds in area one-half the effective area of the said tympanum; the tympanum being of sufficient area to impart to the surrounding free air, when vibrated, sound waves substantially corresponding in intensity to the original sound waves.

5. An acoustic device, comprising a tympanum support having a circular aperture, and a light vibratile tympanum exceeding nine inches in diameter, having its outer edge

rigidly mounted on said support; said tympanum being shaped to provide an annular rim adjacent said support, and a conical portion springing from the inner edge of said annular rim, the diameter of the base of said conical portion being not less than eight-tenths of the said circular aperture in said support.

[fol. 40] 6. An acoustic device, comprising a tympanum support having a circular aperture, and a light vibratile tympanum

2308. ∧ [diaphragm]* mounted in said aperture and having its outer edge secured to said support; said tympanum being shaped to provide an annular rim, the outer

A. [inner]* ∧ diameter of which exceeds nine inches, and a conical portion springing from the inner edge of said annular rim, the altitude of said conical portion being substantially one-fourth of the diameter of its base.

7. An acoustic device, comprising a tympanum support having a circular aperture exceeding nine inches in diameter, and a light vibratile tympanum mounted in said aperture and having its outer edge rigidly secured to said support; said tympanum being shaped to provide an annular rim adjacent said support, and a conical portion springing from the inner edge of said annular rim, the diameter of the base of said conical portion being not less than eight-tenths of the diameter of said circular aperture, and the altitude of said conical portion being substantially one-quarter of the diameter of its base.

[*Words and figures enclosed in brackets erased in copy.]

Insert B'. Per A

[Cl. 8]

8. An acoustic device, comprising a tympanum of colloidal material rigidly supported at its periphery and having a free area exceeding nine inches in diameter and a conical portion substantially eight-tenths of the diameter of said

[fol. 41] free area, the altitude of said conical portion being substantially one-quarter of the diameter of its base.

9. An acoustic device, comprising a tympanum of compressed fibrous material rigidly supported at its periphery and having a free area exceeding nine inches in diameter and a conical portion substantially eight-tenths of the diameter of said free area, the altitude of said conical portion being substantially one-quarter of the diameter of its base.

10. An acoustic device, comprising a tympanum of compressed fibrous material rigidly supported at its periphery and having a free area exceeding nine inches in diameter and a conical portion substantially eight-tenths of the diameter of said free area.

11. An acoustic device, comprising a tympanum freely exposed to unconfined air and comprising a conical portion of compressed fibrous material, upon the apex of which portion shocks or vibrations are adapted to be impressed in a direction such that said shocks or vibrations will move the entire conical portion bodily.

12. An acoustic device, comprising a tympanum freely exposed to unconfined air and comprising a conical portion upon the apex of which shocks or vibrations are adapted to be impressed in a direction such that said shocks or vibrations will move the entire conical portion bodily; said coni-

cal portion being of sufficient area to impart to the surrounding free air, when vibrated, sound waves substan-

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[fol. 42] tially corresponding in intensity to the generating (original) shocks or vibrations.

13. An acoustic device, comprising a tympanum freely exposed to unconfined air and comprising a conical portion of compressed fibrous material, upon the apex of which portion shocks or vibrations are adapted to be impressed in a direction such that said shocks or vibrations will move the entire conical portion bodily; the said conical portion being of sufficient area to impart to the surrounding free air, when vibrated, sound waves substantially corresponding in intensity to the original shocks or vibrations.

[Matter enclosed between rules erased in copy.]

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In testimony whereof I affix my signature.

Marcus C. Hopkins.

OATH

COUNTY OF NEW YORK,
State of New York, ss:

Marcus C. Hopkins, the above named petitioner, being duly sworn, deposes and says, that he is a citizen of the United States and a resident of the borough of Manhattan, City, County and State of New York; that he verily believes himself to be the original, first and sole inventor of the improvements in acoustic devices described and claimed in the annexed specification, which is a division of his former application for United States Letters Patent, Serial Number [fol. 43] 778,826, filed July 14, 1913; that he does not know and does not believe that the same was ever known or used before his invention or discovery thereof, or patented or described in any printed publication in any country before

his invention or discovery thereof, or more than two years prior to his said application, or in public use or on sale in the United States for more than two years prior to his said application; that said invention has not been patented in any country foreign to the United States on an application filed by him or his legal representatives or assigns more than twelve months prior to the said application; and that no application for patent on said improvement has been filed by him, or his representatives or assigns in any country foreign to the United States, except as follows:

Austria, filed July 14, 1914, Ser. No. A. 6151;

Belgium, filed July 14, 1914, Ser. No. 220,014; Patented July 14, 1914, No. 269,216;

Canada, filed July 28, 1915, Ser. No. 196,573; Patented April 25, 1916, No. 169,043;

Denmark, filed July 13, 1914, Ser. No. 1,228; Patented January 25, 1916, No. 20,972;

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France, filed July 13, 1914, Ser. No. 72,606, Patented July 13, 1914, No. 475,109;

Germany, filed July 14, 1914, Ser. No. D 31161, Patented July 15, 1914, No. 286,137;

Great Britain, filed July 11, 1914, Ser. No. 16,602, patented July 14, 1913, No. 16,602;

Holland, filed June 11, 1915, Ser. No. 5,981;

Italy, filed July 15, 1914, Patent No. 144,682;

[fol. 44] Norway, filed July 13, 1914, Ser. No. 6,718, Patent No. 26,721;

Sweden, filed July 11, 1914, Ser. No. 1,937;

Switzerland, filed July 14, 1914, Ser. No. 81,372, Patent No. 71,939.

Marcus C. Hopkins.

Subscribed and sworn to before me, this 6th day of April, 1918. M. A. Bill, Notary Public, Kings Co. Cert. filed N. Y. Co. Notary #255.

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Div. 23

New York, N. Y., April 11, 1918.

Honorable Commissioner of Patents, Washington, D. C.

SIR: The application to which this communication is attached is filed as a division of a prior application of the same inventor, originally filed July 14, 1913, Serial No. 778,826, renewed March 22, 1918, Serial No. 224,048. The earlier application contains a disclosure of the complete machine or apparatus, whereas on the other hand, the present application is restricted to the diaphragm or tympanum per se. For that reason, the drawings of the earlier application contain many figures which have no bearing on the invention claimed in the present case, and during a discussion with the Examiner in charge of the earlier case, the suggestion was made by him that the divisional case be restricted to a single figure which would show as little as possible of the structure irrelevant to the invention. This course has ac- [fol. 45] cordingly been followed, the single figure of the present case corresponding to the Fig. 4 of the earlier application.

Very respectfully, Pennie, Davis, Marvin and Edmonds, Attorneys for Applicant.

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In the United States Patent Office

Application of Marcus C. Hopkins. Filed April 17, 1918. Serial No. 229,014. Sound Regenerating Machines

New York, N. Y., April 19, 1918.

Honorable Commissioner of Patents, Washington, D. C.

SIR: Prior to action on the merits of the case, entry of the following amendments is hereby directed:

In lines 3 and 4 of each of Claims, 1, 2 and 3, change, "substantially" to "the diameter of which is not less than"

Claim 6, line 5, change "inner" to "outer."

Cancel Claims 8 to 13, inclusive.

The amendments to Claims 1 to 3, and 6, have been made to render the present case consistent with the disclosure in the parent case, Serial No. 778,826, filed July 14, 1913.

Claims 8 to 13 have been cancelled in order to reduce the number of claims and for the further reason that the [fol. 46] subjects matter thereof are adequately covered in the claims retained.

Very respectfully, Pennie, Davis, Marvin, and Edmonds, Attorneys for Hopkins.

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2—073

Department of the Interior, United States Patent Office, Washington

June 5, 1918.

Petition. Application of M. C. Hopkins. Serial No. 229,014. Invention: ——.

This petition is referred to the Examiner in charge of Division 23 for recommendation.

In case he recommends adversely he will state his reasons therefor and furnish a copy thereof to petitioner.

J. T. Newton, Commissioner of Patents.

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[fol. 47]

#7
B11876

Div. 23

In the United States Patent Office

Application of Marcus C. Hopkins. Filed April 17, 1928. Serial No. 229,014. Sound Regenerating Machines. Allowed April 29, 1918

New York City, June 3, 1918.

Hon. Commissioner of Patents, Washington, D. C.

Sir: Entry of the following additional claim is requested under the provisions of Rule 78.

"8. An acoustic device, comprising a tympanum embodying a bodily movable, central conical portion, and an annular rim which encircles said conical portion and which is rigidly supported, said conical portion being freely ex-

P. D. M. & E. B'.

posed on all sides to unconfined air and being of sufficient area to produce self-sustaining sound waves in the surrounding air when vibrated, substantially as described."

Sigs.

Remarks

The above claim-as been submitted informally to both the Principal and Assistant Examiners in charge of the [fol. 48] case, and has been accepted as allowable, no further search being necessary.

Very respectfully, Pennie, Davis, Marvin & Edmonds,
Attorneys for Hopkins.

claim requiring no further search,

The proposed [corrections being merely formal,]* it is recommended that this amendment be entered under Rule 78, without withdrawing the case from issue. The final fee has not been paid.

W. D. Groesbeck, Examiner, Div. 23.

[In margin:] Approved: Jun. 6, 1918. R. P. Whitehead, First Assistant Commissioner.

229014—20

Address only "The Commissioner of Patents, Washington, D. C.," and not any official by name.

All communications respecting this application should give the serial number, date of filing, title of invention, and name of the applicant.

B—T

Department of the Interior, United States Patent Office, Washington

Examiner's Amendment

June 8, 1918.

Pennie, Davis, Marvin & Edmonds, 35 Nassau St., New York, N. Y.:

Please find below a communication from the examiner in charge of the application of Marcus C. Hopkins, for Acous- [fol. 49] tic Devices, Filed April 17, 1918, Serial No. 229,014.

James T. Newton, Commissioner of Patents.

[*Words and figures enclosed in brackets erased in copy.]

In accordance with the provisions of Order No. 2308, dated March 12, 1917, which reads in part as follows:

* * * * * * *

Obvious informalities in the application may be corrected by the examiner, but said correction must be in the form of an amendment, approved by the Principal Examiner in writing, placed in the file, and made a part of the record. The changes specified in the amendment will be entered by the clerk in the regular way.

* * * * * * *

the changes, hereinafter specified, are made by the examiner in the application above identified.

Should these changes not be satisfactory to the applicant, appropriate amendment may be proposed under the provisions of Rule 78, provided the specification has not been printed.

The application has been amended as follows:

Claim 6, line 3; change —diaphragm— to "tympanum."

W. D. Groesbeck, Examiner.

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[fol. 50] Address only The Commissioner of Patents, Washington, D. C.

LETTER No. 6

G

Department of the Interior, United States Patent Office, Washington

AMENDMENT

In the Matter of the Application of Marcus C. Hopkins. Acoustic Devices. Filed April 17, 1918. Serial No. 229,014

June 7, 1918.

SIR: You are hereby informed that the recommendation of the examiner that the amendment be admitted under the

provisions of Rule 78, has been approved by the First Assistant Commissioner and the amendment entered.

By direction of the Commissioner:

Very respectfully, M. H. Coulston, Chief Clerk. F.

Marcus C. Hopkins, c/o Pennie, Davis, Marvin & Edmonds, 35 Nassau St., New York City.

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[fol. 51] 2-181

Address only The Commissioner of Patents, Washington, D. C.

Serial No. 229,014

AH

Department of the Interior, United States Patent Office, Washington

Apr. 29, 1918.

Marcus C. Hopkins, Assor.:

SIR: Your application for a patent for an improvement in Acoustic Devices, filed April 17, 1918, has been examined and allowed.

The final fee, Twenty Dollars, must be paid not later than **six months from** the date of this notice of allowance. If the final fee be not paid within that period, the patent on this application will be withheld, unless renewed with an additional fee of $15, under the provisions of Section 4897, Revised Statutes.

The office delivers patents upon the day of their date, and on which their term begins to run. The printing, photolithographing, and engrossing of the several patent parts, preparatory to final signing and sealing, will require about four weeks, and such work will not be undertaken until after payment of the necessary fee.

When you send the final fee you will also send, distinctly and plainly written, the name of the inventor, title of invention, and serial number as above given, date of allow-

[fol. 52] ance (which is the date of this cricular), date of filing, and, if assigned, the names of the assignees,

If you desire to have the patent issue to assignees, an assignment containing a request to that effect, together with the fee for recording the same, must be filed in this office on or before the date of payment of final fee.

After issue of the patent uncertified copies of the drawings and specifications may be purchased at the price of five cents each. The money should accompany the order. Postage stamps will not be received.

Final fees will not be received from other than the applicant, his assignee or attorney, or a party in interest as shown by the records of the Patent Office.

Respectfully, J. T. Newton, [Thomas Ewing,]*
Commissioner of Patents.

Pennie, Davis, Marvin & Edmonds, 35 Nassau Street, New York, N. Y.

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On left margin: In remitting the final fee give the serial number at the head of this notice.

On right margin: Uncertified checks will not be accepted.

[fol. 53] $20 Rec'd. Jun. 8, 1918. C. C. U. S. Pat. Office.

2-327

4213

MEMORANDUM OF FEE PAID AT UNITED STATES PATENT OFFICE

(Be careful to give correct Serial No.)

June 1, 1918.

Serial No. 229,014.
Inventor: Marcus C. Hopkins.
Patent to be Issued to Lektophone Corporation.
Name of Invention, as Allowed: Acoustic Devices.
Date of Payment: June 3, 1918.
Fee: Twenty dollars.
Date of Filing. April 17, 1918.
Date of Circular of Allowance: April 29, 1918.

[*Words and figures enclosed in brackets erased in copy.]

The Commissioner of Patents will please apply the accompanying fee as indicated above.

Pennie, Davis, Marvin & Edmonds, Attorneys.

Send Patent to Pennie, Davis, Marvin & Edmonds, 35 Nassau Street, New York City.

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[fol. 54] Mail Room, Nov. 4, 1924, U. S. Patent Office

#7

UNITED STATES DISTRICT COURT, SOUTHERN DISTRICT OF NEW YORK

Honorable Commissioner of Patents, Washington, D. C.

SIR: In compliance with the Act of February 18, 1922

42

([41]* Stat. L. 3921), you are advised that there was filed on the 31st day of October, 1924, in this court an action, suit, or proceeding No. 530,234, entitled: Name: Lektophone Corporation, Plaintiff. Address: Jersey City, N. J., versus Name: Western Electric Company, Inc., Defendant. Address: New York, N. Y., brought upon the following patents:

	Patent No.	Date of patent	Patentee
1.	1,271,529	Apr. 17, 1918	Lektophone Corp.
2.			
3.			
4.			
5.			

In the above-entitled case, on the — day of ——, 192—, [fol. 55] the following patents have been included by — (insert amendment, answer, cross bill, or other pleading):

	Patent No.	Date of patent	Patentee
1.			
2.			
3.			
4.			
5.			

[*Words and figures enclosed in brackets erased in copy.]

In the above-entitled case the following decision has been rendered or decree issued:

. . . . . .

. . . . . .

In witness whereof I have affixed my hand this 3rd day of November, 1924, at New York, N. Y.

Alex. Gilchrist, Jr., Clerk of Said Court.

Mail Room, May 26, 1925, U. S. Patent Office

#8

UNITED STATES DISTRICT COURT, EASTERN DISTRICT OF NEW YORK

Honorable Commissioner of Patents, Washington, D. C.

SIR: In compliance with the Act of February 18, 1922
42
([41]* Stat. L. —), you are advised that there was filed on [fol. 56] the 3rd day of March, 1925, in this court an action, suit, or proceeding No. 2075, entitled Name: Lektophone Corp., Plaintiff, Address: Jersey City, N. J., versus Name: Sylo Lighting Fixture Co., Defendant, Address: 166 Flatbush Ave., Brooklyn, New York, brought upon the following patents:

	Patent No.	Date of patent	Patentee
1.	1,271,527	July 2, 1918	Plaintiff as Assignee
2.	1,271,529	July 2, 1918	Plaintiff as Assignee
3.	.....	.....	.....
4.	.....	.....	.....
5.	.....	.....	.....

In the above-entitled case, on the — day of ——, 192–, the following patents have been included by — (insert amendment, answer, cross bill, or other pleading):

[*Words and figures enclosed in brackets erased in copy.]

Patent No.	Date of patent	Patentee
1.		
2.		
3.		
4.		
5.		

In the above-entitled case the following decision has been rendered or decree issued:

.....

.....

[Matter enclosed between rules erased in copy.]

[fol. 57] In witness whereof I have affixed my hand this 25th day of May, 1925, at Brooklyn, New York.

Percy G. B. Gilker, Clerk of Said Court.

229014—26

Mail Room, Nov. 3, 1926, U. S. Patent Office

#9

UNITED STATES DISTRICT COURT, DISTRICT OF NEW JERSEY

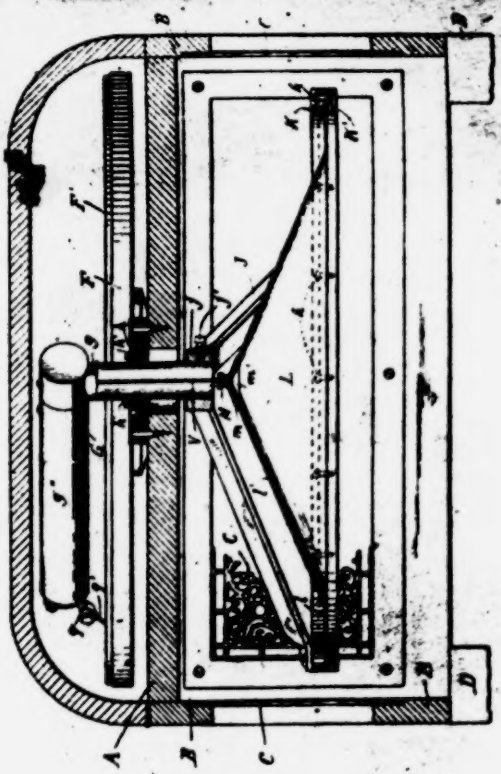
Honorable Commissioner of Patents, Washington, D. C.

SIR: In compliance with the Act of February 18, 1922 42
([41]* Stat. L. —), you are advised that there was filed on the 4th day of September, 1925, in this court an action, suit, or proceeding, No. E.—1431, entitled Name: Lektophone Corporation, Plaintiff, Address: Jersey City, N. J., versus Name: De Forest Radio Company, Defendant, Address: 139 Franklin St., Jersey City, N. J., brought upon the fol-
[fol. 58] lowing patents:

Patent No.	Date of patent	Patentee
1. 1,271,527	July 14, 1913	Marcus C. Hopkins
2. 1,271,529	July 14, 1913	Marcus C. Hopkins
3.		
4.		
5.		

[*Words and figures enclosed in brackets erased in copy.]

1,271,529. Patented July 2, 1918.



Inventor
Marcus C. Hopkins
By Attorneys
Pennie, Davis, Marvin & Edmonds

30

In the above-entitled case, on the — day of ——, 192–, the following patents have been included by — (insert amendment, answer, cross bill, and other pleading):

Patent No.	Date of patent	Patentee
1.		
2.		
3.		
4.		
5.		

In the above-entitled case the following decision has been rendered or decree issued:

. . . . . .

. . . . . .

In witness whereof I have affixed my hand this 28th day of October, 1925, at Trenton, N. J.

George T. Cranmer, Clerk of said Court. R. S. Chevrier, Deputy.

229014—27

(Here follows drawing, side folio 59)

[fol. 60] United States Patent Office

Marcus C. Hopkins, of New York, N. Y., Assignor by Mesne Assignments, to Lektophone Corporation, of New York, N. Y., a Corporation of Delaware

Acoustic Device

Specification of Letters Patent

1,271,529. Patented July 2, 1918

Original application filed July 14, 1913. Serial No. 778,826. Renewed March 22, 1918, Serial No. 224,048. Divided and this application filed April 17, 1918. Serial No. 229,014

To all whom it may concern:

Be it known that I, Marcus C. Hopkins, a citizen of the United States, residing in the borough of Manhattan, city,

county, and State of New York, have invented certain new and useful Improvements in Acoustic Devices; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to instruments which reproduce sounds; and is particularly directed to the attainment of a direct propagation, in free air, from a record or equivalent element subjected to the action of the original sound waves or vibrations, of self-sustaining sound waves substantially corresponding in intensity and amplitude, as well as in pitch or timbre, to the said original sound waves, as distinguished from an initial generation of violent air disturbances in a confined space, and a subsequent transformation of such disturbances into self-sustaining sound waves by means of a megaphone, horn or other amplifier.

In the case of a talking machine, the device employed to propagate the regenerated sound waves in air comprises the reproducer or sound-box and the horn; but the reproducer alone is incapable of propagating sound waves of the character above stated because of the fact that the air disturbances which are produced by its diaphragm and which issue through its mouth-piece are almost immediately dissipated in heat or in waves which are not heard at any considerable distance if the horn be removed. Consequently, it is usual in all instruments of the class indicated to employ an amplifier of some sort to resist transformation into heat and to control the lateral form of the wave during a progressive spreading action which is accompanied by a lessening of the violence of the disturbance until a wave front of great area is attained having a movement appropriate to the sound conductivity of air. In this way, it has been found practicable to transform a satisfactory part of the energy, obtained from a moving record, into self-sustaining sound waves in air; but in every instance such method has been accompanied by distortions of the true recorded sounds in the reproducer, and more particularly in the horn or amplifier, giving rise to those characteristic sounds known as phonograph and horn sounds. These distortions of the true sounds are in a measure impressed upon the record in its making, but are more noticeable in the reproduction, where a suppression of character and overtones,

the loss of timbre in instruments and the voice, and the accentuation of notes of certain pitch, so change the recorded number that a faithful reproduction is not obtained.

It is the object of the present invention to regenerate the original sounds directly from the record or other element subjected to the action of such sounds, without interposition of a confined body of air and without the employment of a restrictive transformer, such as a horn. According to the invention, the sound regenerator comprises a tympanum of relatively great area freely exposed to unconfined air, in which the sounds are to be propagated; the vibrations produced by the record or its equivalent,—that is, the element on which the original sounds or sound waves are recorded, or which is otherwise subjected to the vibrating action of said sounds or sound waves and may, therefore, be termed the "sound-vibrated" element—being faithfully transmitted to the tympanum in such manner that the latter excites directly in the free air surrounding it, sound waves of an intensity and amplitude substantially corresponding to the original sound waves. In other words, the original sounds are directly regenerated by the vibrating tympanum without the interposition of a restrictive or sound modifying transformer.

The invention consists, briefly, in the provision of a tympanum of novel construction, which is capable of responding to the high frequency vibrations employed in the reproduction of sounds, and of imparting these vibrations to a large body of air; and it is to be considered as a division of the invention shown and described in my prior application, renewed March 22, 1918, No. 224,048.

The accompanying drawing illustrates the improved tympanum incorporated in a sound-producing machine of the kind disclosed in said application, the single figure being a vertical sectional view taken transversely through the [fol. 61] machine. Reference may be had to this application for a disclosure of the complete machine; and in order to facilitate an understanding of the present invention as compared with such disclosure, the same reference characters will be employed as in the said earlier application to indicate corresponding parts.

The machine represented in said drawing is mounted within a cabinet having a deck A, upon which the motor

(not shown) and the sound regenerator are mounted. Side walls B extend downwardly from the edges of the deck A, and are preferably apertured in all sides and provided with openwork grills C, which afford substantially uninterrupted air paths for the sound waves from the interior of the cabinet in all directions laterally to the surrounding atmosphere. In the machine shown, the cabinet is bottomless and provided with legs D at its four corners. The motor may be of any suitable type, and is connected to drive the shaft of the turn-table F through the intermediary of gearing, as is usual, said shaft projecting upwardly through the deck A. The turn-table carries the record F′, which in this instance is the element directly acted upon by the original sound vibrations which are to be subsequently regenerated or reproduced; that is to say, the record, in the present construction, is the "sound-vibrated" element.

The sound regenerator has a right-angled tubular support G, the vertical arm g of which is engaged at diametrically-opposite points by bearing screws h′, which project inwardly from and are carried by a ring h of larger diameter than the said arm g, as described in said prior application. The screws h′ form an horizontal axis perpendicular to the horizontal arm g″ of the right-angled support G, about which axis the arm g″ can swing in a vertical plane, the vertical arm g the while being inclined within the ring h. The latter forms part of an annular bearing device secured upon the deck A, the open central portion of which device alines with an opening of larger diameter in said deck, and the said vertical arm g of the support G extends downwardly through these openings and has its lower extremity fitted in the hub j of a conical spider J and fastened to the same by a set screw j′.

The spider J in the present construction has three arms, only two of which appear, however; and to the lower ends of these arms there is secured by screws an annulus consisting of two ponderous rings K, K′ of metal, which are clamped together by screws k spaced at short intervals. Two of the three arms of the said spider are screwed tightly to the rings K, K′, and the third is so arranged that the rings K, K′ can be secured at varying distances from the foot of this third arm, there being sufficient spring in the spider arms to permit of an adjustment at this point of one-

quarter of an inch or so, if desired. This detail is illustrated in my earlier case, and for that reason is not represented in the present case.

The tympanum L, which forms the subject of the present case, is constructed of light, vibratile material and has an annular plane peripheral portion or supporting rim l, the outer edge of which is tightly gripped and rigidly supported between the rings K, K′, and a central conical portion l′ rising from the inner edge of the said rim l. If satisfactory regeneration of sounds from a record or other sound-vibrated element is to be had, the whole diameter of the tympanum, that is, the diameter of the aperture in the rings K, K′ should exceed nine inches in order that the conditions required to regenerate the sound waves in the manner above described shall be fulfilled. The base of the central conical portion l′ should exceed in area one-half of the effective area of the entire tympanum, that is, the area of the aperture in the rings K, K′; or in other words, the diameter of the base of said conical portion should be at least eight-tenths of the diameter of the said aperture. The altitude of the conical portion l′ should be at least one-quarter of the diameter of its base.

It is, of course, possible to make some variation from the approximate sizes given without materially altering the result; but if the tympanum is constructed as shown in the drawing, any great variation from these proportions will be found to affect the character of the reproduction. It is of vital importance that the tympanum be made of crisp, strong material, having considerable rigidity within itself, and it is also of vital importance that the tympanum as a whole be extremely light and have as little inertia as possible without a weakening effect. The tympanum is shown of conical form with a smooth surface, and this has been found to be very satisfactory. The conical shape is given the tympanum so that shocks or vibrations impressed upon the apex of the cone in a direction toward its base will move the whole cone bodily, the strains being imparted edgewise of the material and no wave motions being set up in the thin material of the cone. The curvature of the walls of the cone precludes the setting up of waves in the material; and the intended object, a simultaneous movement of the whole conical portion of the tympanum, is thus attained.

While I prefer to construct the tympanum in the form described, and shown with a smooth surface, especially in view of the ease of construction, yet it is possible to form radial or concentric corrugations in the plane peripheral portion l and produce a light, stiff and very satisfactory article for [fol. 62] the purpose. It is conceivable, too, that when the tympanum is provided with corrugations as just suggested, some variation from the proportions above given may be made; but such variations will not be great. The tympanum should preferably be constructed of a colloidal substance, and should be from 3 to 20 thousandths of an inch in thickness according to the crispness or stiff character of the material used. Compressed fibrous material, such as hot pressed paper or fiber, has been found to act satisfactorily.

It will be noted that in the construction illustrated, the arms of the spider J incline downwardly to correspond with the conical shape of the tympanum L, the apex of the conical portion of the tympanum pointing upwardly toward the deck A of the cabinet, and, also, that the concave side of the said tympanum is open to the surrounding atmosphere through the open bottom of the cabinet, no obstructions being presented to the sound waves issuing from the concave surface of the tympanum.

A cap M is secured to the apex of the conical portion l of the tympanum, and this cap should be of more rigid construction than the remainder of the tympanum and should preferably be three-eighths of an inch or more in diameter. I prefer to make the cap M of metal, extremely light but very rigid, and in the form of two cones m, m′ screwed tightly together upon opposite sides of the tympanum so as to grip the material thereof with their edges. In order that a tight and positive application of the cones forming the cap M to the conical portion of the tympanum may be had, it is preferable to form the inner cone m′ of lesser angle, and the outer cone m of greater angle than the said conical portion, in which case their edges will securely grip the tympanum material when they are fastened together.

The vibrations or sound waves originally imparted to the record or its equivalent may be transmitted therefrom to the tympanum to vibrate the same in the manner and by means of the mechanism shown and described in my afore-

said aplication above identified, or by means of some other approved transmission means or mechanism, as will be understood. In any event, such means or mechanism forms no part of the present case, however, and for that reason requires no extended disclosure. It is believed sufficient to state, therefore, that in the arrangement illustrated the mechanism in question is located within the horizontal arm g″ of the support G, and is connected at its forward end with the stylus holder q, the other end of said mechanism having connected to it a vertical rod V, which extends downwardly through the interior of the vertical arm g of the support and is rigidly secured to the cap M of the tympanum. In consequence, the vibrations of the stylus q mounted in said holder and produced in the usual way by the phonic lines on the record, will be transmitted from the stylus through the transmission mechanism to the rod V, which will be vibrated endwise, the endwise vibrations of said rod being directly impressed upon the tympanum L.

I claim:

1. An acoustic device, comprising a tympanum rigidly supported at its periphery and having a free area exceeding nine inches in diameter and a conical portion, the diameter of which is not less than eight-tenths of the diameter of said free area.

2. An acoustic device, comprising a tympanum rigidly supported at its periphery and having a free area exceeding nine inches in diameter and a conical portion, the diameter of which is not less than eight-tenths of the diameter of said free area, said conical portion being rigid in the direction of the axis of the tympanum.

3. An acoustic device, comprising a tympanum rigidly supported at its periphery and having a free area exceeding nine inches in diameter and a conical portion, the diameter of which is not less than eight-tenths of the diameter of said free area, the altitude of said conical portion being substantially one-quarter of the diameter of its base.

4. An acoustic device, comprising a tympanum support having a circular aperture, and a light tympanum freely exposed to unconfined air and having its outer edge rigidly mounted on said support in said aperture; said tympanum having a central conical portion, the base of which exceeds

in area one-half the effective area of the said tympanum; the tympanum being of sufficient area to impart to the surrounding free air, when vibrated, sound waves substantially corresponding in intensity to the original sound waves.

5. An acoustic device, comprising a tympanum support having a circular aperture, and a light vibratile tympanum exceeding nine inches in diameter, having its outer edge rigidly mounted on said support; said tympanum being shaped to provide an annular rim adjacent said support, and a conical portion springing from the inner edge of said annular rim, the diameter of the base of said conical portion being not less than eight-tenths of the said circular aperture in said support.

6. An acoustic device, comprising a tympanum support having a circular aperture, and a light vibratile tympanum mounted in said aperture and having its outer edge secured to said support; said tympanum being shaped to provide an [fol. 63] annular rim, the outer diameter of which exceeds nine inches, and a conical portion springing from the inner edge of said annular rim, the altitude of said conical portion being substantially one-fourth of the diameter of its base.

7. An acoustic device, comprising a tympanum support having a circular aperture exceeding nine inches in diameter, and a light vibratile tympanum mounted in said aperture and having its outer edge rigidly secured to said support; said tympanum being shaped to provide an annular rim adjacent said support, and a conical portion springing from the inner edge of said annular rim, the diameter of the base of said conical portion being not less than eight-tenths of the diameter of said circular aperture, and the altitude of said conical portion being substantially one-quarter of the diameter of its base.

8. An acoustic device, comprising a tympanum embodying a bodily movable, central conical portion, and an annular rim which encircles said conical portion and which is rigidly supported, said conical portion being freely exposed on all sides to unconfined air and being of sufficient area to produce self-sustaining sound waves in the surrounding air when vibrated, substantially as described.

In testimony whereof I affix my signature.

Marcus C. Hopkins.

[fol. 64]

2—421

1918

CONTENTS

1. Application—2 papers.
2. Letter—Apl. 12/18.
3. Amdt. A. 4/20/18.
4. Amdt. B. June 3/18.
5. Exrs. Amdt. 6/8/18.
6. Notice of Entry of Amendment—June 7/18.
7. Notice of Suit—Nov. 4, 1924.
8. Notice of Suit—May 26, 1925.
9. Notice of Suit—Nov. 3, 1925.
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[fol. 65]

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229014—28

(Here follows drawing, side folio 66)

[fol. 67] [Endorsed:] No. 1726. United States District Court. Lektophone vs. Rola. Plfts. Exhibit No. 6. Filed 5/10/28. Walter B. Maling, Clerk. By A. C. Aurich, Deputy Clerk.

No. 5712. United States Circuit Court of Appeals for the Ninth Circuit. Filed Feb. 5, 1929. Paul P. O'Brien, Clerk.

[fol. 68] PLAINTIFF'S EXHIBIT NO. 7

2—390

DEPARTMENT OF COMMERCE, PATENT OFFICE

To all persons to whom these presents shall come, Greeting:

This is to certify that the annexed is a true copy from the records of this office of the File Wrapper, Contents and Drawings, in the matter of the Letters Patent of Marcus C. Hopkins, Assignor, by Mesne Assignments, to Lektophone Corporation, Number 1,271,527, Granted July 2, 1918, for Improvement in Sound-Regenerating Machines.

In testimony whereof I have hereunto set my hand and caused the seal of the Patent Office to be affixed, at the City of Washington, this fourteenth day of November, in the year of our Lord, one thousand nine hundred and twenty-five and of the Independence of the United States of America the one hundred and fiftieth.

Thomas E. Robertson, Commissioner of Patents.

Attest: D. E. Wilson, Chief of Division. (Seal.)

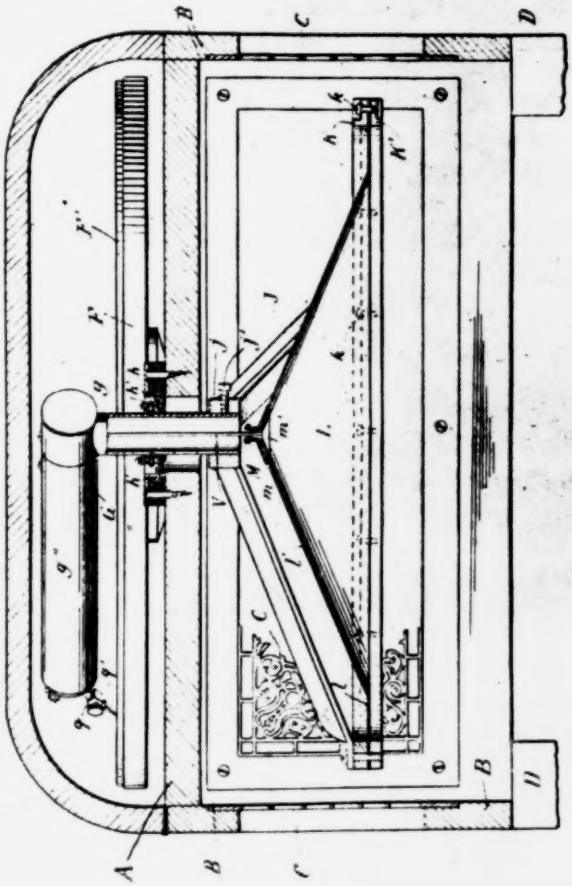
M. C. HOPKINS.

ACOUSTIC DEVICE.

APPLICATION FILED APR. 17, 1918.

1,271,529.

Patented July 2, 1918.



Inventor:
Marcus C. Hopkins

By Attorneys
Pennie, Davis, Marvin & Edmonds

Apr 22 1918

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[fol. 69] Renewal. 2036
1913

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(Ex'r's Book) 245

Div. 20
Number (Series of 1900), Series of 1915.
[778.826]* 224048 Patent No. 1271527
Name—Marcus C. Hopkins, Assor. [to John C. Pennie and William H. Davis, both of New York, N. Y.,]* by mesne assigts, to Lektophone Corporation, of N. Y., [New York,]* a Corp. of Delaware, of Jersey City.
County of .....
State of New Jersey.
Invention—Sound Regenerating Machine.

Parts of Application Filed.	Original	Renewed
	Petition— July 14, 1913	Mar. 22, 1918
	Affidavit— " " 1913	....., 191-
	Specification— " " 1913	....., 191-
	Drawing, 5 sheets " " 1913	Certificate of
	Photo Copy— , 191-	Correction, 191-
	First Fee Cash—	Sept. 28, 1920
	$15, July 14, 1913	$15, Mar. 22, 1918
	First Fee Cert.— ,191-	
	Appl. filed com-	....., 191-
	plete— July 14, 1913	Mar. 22, 1918

Division of App. No. ....., filed ....., 191..

[fol. 70]

Examined and Passed	Pr.—examined and
for Issue April 7, 1916	passed— April 23, 1918
W. D. Groesbeck	W. D. Groesbeck, Exr.
Exr. Div. 23	Div. 232
Notice of Allowance—	May 1, 1918
Apr. 11, 1916, , 191-	4 $20 June 3, 1918
By Commissioner.	....., 191-
Final Fee Cash— , 191-	
Final Fee Cert.— , 191-	
Patented July 2, 1918	

[*Words and figures enclosed in brackets erased in copy.]

Attorney—Pennie, Davis & Goldsborough, #35 Nassau Street, New York, N. Y.
Associate Attorney .....
(No. of Claims Allowed—31) Title as Allowed—Sound-Regenerating Machine (Cl. [181—3]*)

274—16

Memorandum.

The first fee of $15, applied to the application of Marcus C. Hopkins, was included in composite letter No. — received July 14, 1913, from Pennie, Davis & Goldsborough, which letter is on file in the Mail Room.

A. C. Cosdon, Application Clerk.

778826—1

[fol. 71] Mail Room, Jul 14, 1918, U. S. Patent Office

(Div. 23.)

778,826

11759

Petition.

2036

To the Commissioner of Patents:

Your petitioner Marcus C. Hopkins, a citizen of the United States, residing at No. 2859 Boulevard, Jersey City, County of Hudson and State of New Jersey, and whose post-office address is No. 35 Nassau Street, New York City, prays that Letters Patent may be granted to him for improvements in sound regenerating machine as set forth in the annexed specification.

And he hereby appoints John C. Pennie and William H. Davis (constituting the firm of Pennie, Davis & Goldsborough, 35 Nassau Street, New York City), and each of them his Attorneys, with full power of substitution and revocation, to prosecute this application, to make alterations and amendments therein, to sign the drawings, to receive

[*Words and figures enclosed in brackets erased in copy.]

the Patent, and to transact all business in the Patent Office connected therewith.

Marcus C. Hopkins.

[fol. 72] [Specification]*

To all whom it may concern:

Be it known that I, Marcus C. Hopkins, a citizen of the United States, residing at No. 2859 Boulevard, Jersey City, county of Hudson and State of New Jersey, have invented certain new and useful Improvements in Sound-regenerating Machines;

And I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to and use the same.

778826—2

2036

11760

This invention relates to instruments which reproduce sounds, such as the talking machine and the phonograph, and is particularly directed to the attainment of in free air from a record

Per A. a direct propagation ∧ of self-sustaining sound

Per A. waves ∧ [in air from a record,]* as distinguished B1 from an initial generation of violent air disturb-

Per A. ances in a confined space [which would not be propagated as sound,]* and a subsequent transformation of such disturbances into self-sustaining sound waves by means of the megaphone or trumpet, commonly employed with most existing machines.

such regenerated

B. The device employed to propagate ∧ [self sustaining]* sound waves in air from a record I herein term a "regenerator," and, this device in the phono-

[fol. 73] graph and talking machine comprises the "reproducer" together with / the trumpet. The "reproducer" alone is incapa-

[*Words and figures enclosed in brackets erased in copy.]

such
ble of generating ∧ ["self sustaining"]* sound waves in air, and the violent air disturbances which are produced
which
Per A. by its diaphragm, and ∧ issue through its mouth piece, are almost immediately dissipated
[of small volume and high
[in heat or]* tension]*
" " ∧ in waves, ∧ which are not heard [or in heat,
" " at any considerable distance
" " as is at once apparent]* ∧ if the horn be removed.
" " In the case of the "reproducer," [it would appear that]* all of the energy recieved from
relatively violent
the record issues from its mouth as ∧ [high tension]* disturbances, which are impressed upon a very small amount
such
of free air, quite incapable of conducting ∧ disturbances [of such tension]* without transformation losses, and therefore
Per A. ∧ the trumpet is resorted to to resist transfor-
into heat to
mation / and / control the lateral form of the wave during a progressive spreading action, which is ac-
violence of the disturbance,
companied by a lessening of the ∧ [tension,]* un-

having
til a wave front of great area is attained [with]* ∧ a
movement
Per A. [tension]* ∧ appropriate to the sound conductivity of air. In this way it has been found practicable to transform a satisfactory part of the energy obtained from a moving record, into self-sustaining sound waves in air, but in every instance this method has been accompanied by distortions of the true recorded sounds

[*Words and figures enclosed in brackets erased in copy.]

in the reproducer, and more particularly in the trumpet, giving rise to those characteristics sounds, known as phonograph and horn sounds. These distortions of the true sounds are in a measure impressed upon the record in its making, but are more noticeable in the reproduction where a suppression of character and over-tones, the loss of "timbre" in instruments and the voice, and the accentuation of notes of certain pitch, so change the recorded

not obtained

Per A. number that a faithful reproduction is ∧ [comparatively unknown].*

It is an object of the present invention to regenerate the recorded sounds directly from the record, without the in-

and without

Per A. terposition of a confined body of air [or]* ∧ the employment of a restrictive transformer, such as a horn.

The "sound regenerator," in the case of the present invention, comprises a tympanum of relatively great area

unconfined

Per A. freely exposed to ∧ [the]* air, in which the

Per A. sounds are to be propagated, [as such,]* and [fol. 75] a mechanical transmission which faithfully transmit the vibrations produced by the record, to the tympanum, in such a manner that the tympanum ex-

Sub. B².

---

such a as

Per A. cites sound waves of ∧ [a proper]* tension ∧ to in

be self-sustaining in air, [to]* ∧ a body of air of sufficient bulk to receive as sound waves a satisfactory amount of

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the available energy receivable from the record without

of the record

Per A. undue wear ∧.

[Matter enclosed between rules erased in copy.]

[*Words and figures enclosed in brackets erased in copy.]

The invention consists in providing a tympanum of novel construction, which is capable of responding to the high frequency vibrations employed in the reproduction of

of

Per A. sounds, and ∧ imparting these vibrations to a Per A. large body of air; in providing a suitable mounting for this tympanum to permit it to exercise its function, and in providing a vibration transmission for receiving the vibratory movement from the record and transmitting this movement to the tympanum, without change of character and appreciable loss of energy. The invention also comprehends certain combinations of parts and details of construction and location hereinafter particularly described and specifically pointed out in the appended claims.

I have illustrated in the accompanying drawings a sound reproducing machine embodying the several novel features [fol. 76] of the invention as they may be employed in regenerating sounds from records made with either laterally or vertically sinuous grooves.

In the drawings,

Figure 1 is a plan view of the machine with the cover raised.

Fig. 2 is a vertical section on line 2—2 of Fig. 1, with cover and transmission arm raised.

Fig. 3 is a vertical section on line 3—3 of Fig. 1 with cover closed.

Fig. 4 is a vertical section on line 2—2 of Fig. 1 with cover closed and transmission arm in playing position.

Fig. 5 is a longitudinal section through the transmission arm on line 5—5 of Fig. 4.

Fig. 6 is a vertical longitudinal section through the transmission arm on line 6—6 of Fig. 5.

Fig. 7 is a vertical section on line 7—7 of Fig. 6.

Fig. 8 is an end view of the transmission arm.

Fig. 9 is a cross-section on line 9—9 of Fig. 5, and

Fig. 10 is a view similar to Fig. 8 of a modified arrangement for vertically sinuous records.

Referring to the drawings, the illustrated machine is mounted within a cabinet having a deck A upon which the motor and sound regenerator are supported. Side walls B downwardly extending from the edges of the deck A are preferably apertured on all sides and provided with

e

[fol. 77] open work grills C which afford substantially uninterrupted air paths for the sound waves from the interior of the cabinet in all directions laterally to the surrounding atmosphere. In the machine shown the cabinet is bottomless and provided with legs D at its four corners.

The motor may be of any suitable type, that shown having a frame E, spring drums e, winding gear e′, spiral drive gear e″, high pitch spiral table shaft e‴ and governer e⁗. The frame E of the motor is secured against the under side of the deck A depending therefrom and the table shaft pro-

jects upwardly through the deck A and carries the circular record table F above the deck. The motor frame E is preferably insulated from the deck A by rubber washers not shown.

The sound regenerator has a right-angled tubular support G, the vertical arm g of which has diametrically opposite conical depressions g′ which are engaged by pointed screws h′ which project inwardly from and are threaded through a ring h of larger internal diameter than the external diameter of the vertical arm g of the right-angled support G. The pointed screws h′ engage the depressions g′ forming a horizontal axis perpedicular to the horizontal arm g″ of the right-angled support G about which axis the arm g″ can swing in a vertical plane, the vertical arm g the while being inclined within the ring h. The ring h com-

[fol. 78] prises the ring h proper and an annular retaining plate h″ screwed upon the lower face of the ring h, an annular groove at the junction of the ring h and plate h″ receiving the inner edge of a holding plate H in such manner that the ring h and the right-angled support G may be turned about a vertical axis in the holding plate H.

The holding plate H is clamped between two rubber or felt rings i, i′, the lower ring i′ resting upon the deck A. A

ring I is placed upon the top of the upper ring i and screws i″ have their heads seated in the ring I and are screwed down into the *the* deck A. The ring H and the rubber or felt rings i and i′ have large holes through which the screws i″ pass, so that these screws do not come

into contact with the ring H and the right-angled support G is therefore entirely insulated from the deck A by the rubber or felt rings. The vertical arm g of the right-angled support G extends downwardly through an aperture in the deck A at a point near the periphery of the record table F. A conical spider J shown as having three arms has its hub j fitted to the lower extremity of the vertical arm g of the right-angled support G, and is secured thereon by a set scraw j′. To the ends of the arms of the spider J is secured by screws an annul*us* consisting of two ponderous rings K,

#

∧ K′ of metal, these two rings being clamped together
F′. by screws k spaced at short intervals. ∧ [The spider J
[fol. 79] is shown having three arms, two of which]* are screwed tightly to the rings K, K′ and the third is as tightly secured to said rings but by adjustable screws k′ k″ arranged in such manner that the rings K, K′ can be secured at varying distances from the foot of this third leg, there being sufficient spring in the spider legs to permit of an adjustment at this point of one-quarter of an inch or so, if desired. It will be seen that owing to the proximity of the mounting of the vertical arm g of the right-angled support G to the edge of the record table F, the spider J and the

ie

F. rings K, K′ will underl[y]* the record table and permit of a very compact arrangement of the working parts within the cabinet.

A tympanum L of light vibratile material has an annular plane peripheral portion *l*, the outer edge of which

or supporting rim l

Per B. peripheral portion ∧ *l* is tightly gripped

[*Words and figures enclosed in brackets erased in copy.]

and rigidly supported #

F². ∧ between the ponderous rings K, ∧ K′, and a cen-

tral conical portion *l′* rising from the inner edge of the annular plane peripheral portion. If satisfactory regeneration of sounds from a record is to be had, the whole diameter of the tympanum, that is, the diameter of the aperture in the rings K, K′, should exceed nine inches in

C. order that the conditions shall be fulfilled [which are]*

B³. called for by the correlation existing between the range of wave frequencies of the sounds which must be regenerated by a machine of this character and [fol. 80] the wave tension called for by the sound conductibility of free air.

[Matter enclosed between rules erased in copy.]

The base of the central conical portion *l′* of the tympanum should exceed in area one-half the effective area of the entire tympanum, that is, the area of the aperture in the rings #

K, ∧ K′; or in other words, the diameter of the base of said at least

C. conical portion should be [substantially]* eight-tenths of the diameter of the circular aperture in #

the supporting rings K, ∧ K′. The altitude of the conical portion *l′* of the tympanum should be at least

" ∧ [substantially]* one-quarter of the diameter of its base. It is, of course, possible to make some variation from the approximate sizes given without materially altering the result, but if the tympanum is made as shown in the drawings, any great variation from these proportions will be found to affect the character of the reproduction.

[*Words and figures enclosed in brackets erased in copy.]

It is of vital importance that the tympanum be made of crisp, strong material, having considerable rigidity within itself, and it is also of vital importance that the tympanum as a whole be extremely light and have as little inertia as possible without a weakening effect. The tympanum is

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shown of conical form with a smooth surface, and this has been found to be very satisfactory. The conical shape is given the tympanum so that shocks or vibrations impressed [fol. 81] upon the apex of the cone in a direction towards its base will move the whole cone bodily, the strains being imparted edgewise of the material and no wave motions being set up in the thin material of the cone. The curva-

the

ture of the walls of the cone preclude / setting up of waves in the material and the intended object, a simultaneous movement of the whole conical portion of the tympanum, is attained. While I prefer to construct the tympanum in the form described and shown with a smooth surface, especially in view of the ease of construction, yet it is possible to form radial corrugations in the conical portion *l'* and radial or concentric corrugations in the plane peripheral portion *l* and produce a light, stiff and very satisfactory article for the purpose. It is possible that when the tympanum is provided with corrugations as just suggested, C. [that]* some variation from the proportions above given may be found possible, and perhaps advisable, but such variations from the proportions given will not be great. The tympanum should preferably be constructed of a colloidal substance and should be from 3 to 20 thousandths of an inch in thickness according to the crispness or stiff character of the material used. Compressed fibrous material, such as hot pressed paper or fiber, has been found to act satisfactorily,

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but I prefer to employ hard rubber or vulcanite, as it is

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more easily handled, is less affected by weather conditions [fol. 82] and lends itself to the production of a

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[*Words and figures enclosed in brackets erased in copy.]

Per B. more finished commercial product. The hard rubber is pressed to shape while hot from the sheet and allowed to cool in the die. If a polished sheet has been used, the finished tympanum will have a beautifully polished appearance.

[Matter enclosed between rules erased in copy.]

It will be noted that the arms of the spider J incline downwardly to correspond with the conical shape of the tympanum L and that the apex of the conical portion of the tympanum is pointed upwardly toward the deck A of the cabinet, and that the concave side of the tympanum is open to the surrounding atmosphere through the open bottom of the cabinet, no obstructions being presented to the sound waves issuing from the concave surface of the tympanum.

" [It is probable]* that various forms of cabinets
" will be devised for machines of this character, but in practically every case it may be assumed
Per B. that one side of the tympanum will be directed toward some reflecting surface or portion of the cabinet or machine which will in a measure obstruct the sound waves issuing from the tympanum and in every such case the tympanum should have its convex side directed towards the obstructions and its concave side as open as possible toward the free air. This is suggested because the shape of the tympanum admits of a more intense pressive action in propagating a sound wave when a shock is applied to its apex in a direction toward its base than in the opposite direction.

[Matter enclosed between rules erased in copy.]

A cap M is secured to the apex of the conical portion *l'* of

[fol. 83] the tympanum L, and this cap should be of more rigid construction than the remainder of the tympanum and

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[*Words and figures enclosed in brackets erased in copy.]

should preferably be three-eighths of an inch or more in diameter. I prefer to make the cap M of metal, extremely light but very rigid, and in the form of two cones m, m' screwed tightly together upon opposite sides of the tympanum and gripping with their edges the material of the conical portion of the tympanum. In order that a tight and positive application of the cones forming the cap M to the conical portion of the tympanum may be had, it is preferable to form the cone m' of lesser angle than the control portion of the tympanum, and the cone m of greater angle than the conical portion of the tympanum, in which case their edges will securely grip the tympanum material when they are secured together. The cap M is applied to the tympanum to receive the shocks which are to be applied to the tympanum as a whole, and convey them to sufficient of the material of the tympanum to insure the movement of the tympanum as a whole. This will be better understood when it is considered that if the shock were applied to paper or hard rubber at a single small point, the inertia of the tympanum as a whole would be sufficient to resist the attack and the material would be distorted or dented at that point, the effect of the shock upon the tympanum as a whole being entirely lost. The cap M being of hard material such as metal will resist the bending action and distribute the shock to so much of the surface of the material of the tym- [fol. 84] panum as is capable of successfully resisting the

shock, and *and* it will then be transmitted to the tympanum as a whole. The plane peripheral portion l of the tympanum maintains the place of the conical active portion of the tympanum and yields sufficiently to permit of the required motion of the conical portion, resisting, however, displacement of the conical portion in just that degree necessary to maintain the form and neutral position of the active conical portion. Were the plane peripherial portion l of considerably greater width or markedly narrower than described, its function would be destroyed to a degree corresponding to the remoteness of the departure from the approximate proportion given and the effective portion of

the conical portion of the tympanum would be proportionately lessened.

In the tubular arm g'' of the transmission support G are located two ponderous members or weights N and N'. These members N and N' are shown as insulated from the wall of the arm g'' by a tube o of insulating material, such as soft rubber or felt. One at least of the ponderous members N and N' must be movable relatively to the other and therefore it cannot be rigidly secured to the support G, and the insulating material becomes necessary to avoid rattling. I preferably insulate both of the ponderous members or weights N, N' from the wall of the transmission support G. [fol. 85] Pins P projecting from the ponderous member N, and sliding in holes in the other ponderous member N', act as guides and prevent disalinement and angular displacement of the movable ponderous member. Knife edge fulcra n and n' are secured in and project from the ends of the

ponderous members N and N', and in the form of the device shown in Figs. 1 to 9 the fulcra n are arranged horizontally and the fulcra n' are arranged vertically. A lever Q is mounted on the fulcra n' and is capable of movement upon a vertical axis. A style holder q projects from the lever Q downwardly at an incline so that the point of a style q' held in the style holder is considerably removed from the axis of the lever Q and movement given the style q' by the record will effect an oscillation of the lever Q about its vertical axis upon the fulcra n'. The lever Q has arms q'' and q''' projecting from opposite sides thereof, the arm q'' being near the top of the lever Q and the arm q''' being near the bottom of said lever. The reason for this arrangement of the arms upon the lever will presently appear.

A lever R is mounted upon the fulcra n and oscillates upon a horizontal axis. This lever has arms r and r' extending upwardly and downwardly from its opposite sides, the arm r projecting from a point near one end of the lever R, and the arm r' projecting from a point near the other end of the lever R. It will now be seen that a point upon the arm r of the lever R is opposite a similar point on the arm [fol. 86] q'' of the lever Q and these two points are con-

nected by rod link S. It will also be seen that a point upon the arm r′ of the lever R is opposite a point upon the arm q‴ of the lever Q, and these two points are connected by a rod link S′. The rod links S and S′ have eye-ends arranged in planes removed 90° from one another, and these eye-ends s are engaged by pivot screws s′ upon the arms of the levers Q and R. A parallelogram is

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formed by the levers Q and R and the rod links S and S′, and in the form just described, which is adapted for a laterally sinuous groove in the record, oscillation of the lever Q about a vertical axis will produce like oscillations of the lever R about a horizontal axis. Springs T preferably mounted upon the pins P press the ponderous members N and N′ apart forcing the knife edge fulcra n and n′ tightly against the levers R and Q, and put the parallelogram of levers and links under tension, precluding any rattle or looseness of the levers upon the fulcra or of the eye-ends of the links upon their pivot screws, and as the movable ponderous member of the combination is insulated from the transmission support G, no rattle or displacement of the parts can take place when the record groove oscillates the lever Q, but such oscillation will be faithfully transmitted to the lever R. The ponderous members N and N′ have clearance holes s″ for the rod links S and S′.

An arm U projects from the central portion of the lever [fol. 87] R and to its end is rigidly secured a rod V which extends downwardly through the interior of the arm g of the transmission support G, its lower end being rigidly secured to the cap M of the tympanum. The rod V is nicked or thinned at v close to the arm U of the lever R to permit of a slight springing action which compensates for the very slight angular motion of the arm U when the lever R is oscillated. It will now be seen that the oscillation of the lever R about its horizontal axis imparted to it from the lever Q, will effect an

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endwise vibration of the rod V which is directly impressed upon the tympanum L. A cap W closes the opening at the

angle of the transmission support G and the removal of this cap gives access to the working parts of the rear end of the transmission.

Insert F3 (13)

When a vertically sinuous record is employed the lever Q is mounted to oscillate about a horizontal axis, as shown in Fig. 10, no change in the lever R being required.

Insert A1 (2)

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1. The combination of a direct sound regenerating machine and a cabinet therefor having apertures on all sides affording substantially free paths for the sound waves from the regenerator containing cavity of the cabinet to the surrounding atmosphere; substantially as described.

[fol. 88] 2. The combination of a direct sound regenerating machine with a bottomless cabinet containing said machine; substantially as described.

[Cls. 1 & 2]

3. The combination of a direct sound regenerating machine and a cabinet containing said machine, said
Sub. B' cabinet having an aperture leading from the regenerator-containing compartment to the surrounding atmosphere.

4. The combination of a cabinet and a direct sound regenerating machine mounted therein and insulated therefrom; substantially as described.

[Matter enclosed between rules erased in copy.]

3

Per A. [5].* The combination of a cabinet having two
Per A. compartments and a partition there between, of a record table and transmission arm located in one of said compartments and a tympanum located in the

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[*Words and figures enclosed in brackets erased in copy.]

other of said compartments and connected with said transmission arm; substantially as described.

4

Per E. [6].* In a direct sound regeneration machine, the combination of a partition, a transmission arm supported on said partition to swing upon one side thereof and extending therethrough and a tympanum supported upon said transmission arm to swing upon the other side of said partition; substantially as described.

5

[7].* In a direct sound regenerating machine, the combination of a horizontal partition, a transmission support

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[fol. 89] 11775

mounted upon said partition to swing thereover and extending downwardly therethrough and a tympanum carried upon said support beneath said partition; substantially as described.

6

[8].* In a direct sound regenerating machine, the combination of a horizontal partition, a record holder mounted to rotate above said partition, a transmission support mounted upon said partition to swing above said record holder and extending downwardly through said partition and a tympanum carried by said support beneath said partition and under said record holder; substantially as described.

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9. In a direct sound regenerating machine, the combination of a record holder, and a transmission support mounted to swing toward, from and across said record holder; substantially as described.

Per A.

[Matter enclosed between rules erased in copy.]

3 [9 7]*

[10].* In a direct sound regenerating machine, the com-

[*Words and figures enclosed in brackets erased in copy.]

bination of a record holder, a transmission support holder,

C. mounted to swing over said record ∧ [support]* and a tympanum carried by said support and extending under said record holder; substantially as described.

4 [10 8]*

[11].* In a direct sound regenerating machine, the combination with a record holder, of a transmission support mounted to swing about vertical and horizontal axes, said support having an arm extended to move

Insert A². above and across said record holder and ∧ a A²

having a free end and at the free end of

Per B. [fol. 90] second arm ∧ a tympanum carried ∧ [by]* said second arm with its axis at an angle to said first arm; substantially as described.

[11.]*

[12.]* in a direct sound regenerating machine,

Per B. the combination of a bottomless cabinet supported upon legs and a downwardly directed tympanum mounted within said cabinet; substantially as described.

[Matter enclosed between rules erased in copy.]

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5. [12 9]*

[13].* ∧ In a sound regenerating machine, a vibration transmission comprising two ponderous members, fulcra carried by said members, an articulate parallelo-

Per F. gram having opposite sides mounted on said fulcra and means exerting pressure upon said ponderous members to place said parallelogram under tension; substantially as described.

[13]* 6. [10]*

F. [14.]* ∧ In a sound regenerating machine, a vibra-

[*Words and figures enclosed in brackets erased in copy.]

tion transmission comprising two ponderous members, fulcra carried by said members, an articulate parallelogram of non-extensible links and non-flexible levers, the levers of said parallelogram being mounted on said fulcra, and means exerting pressure upon said ponderous
B⁵. members to place said parallelogram under tension; substantially as described.

[fol. 91] [Cls. 7 to 12]

[14]* 7.

[15.]* A. A sound regenerator for directly propagating self-sustaining sound waves in air consisting of a ponderous support having a circular aperture, a light vibratile tympanum having its outer edge mounted on said support, said tympanum being shaped to provide an an-
Per B⁵. nular plane adjacent said support and a conical portion springing from the inner edge of said annular plane, and a cap of nonvibratile material rigidly secured to the apex of said conical portion of said tympanum; substantially as described.

15.

[16.]* A sound regenerator for directly propagating self-sustaining sound waves in air consisting of
Per A. a ponderous support having a circular aperture, a light tympanum mounted upon said support in said aperture, said tympanum having a central conical portion the base of which exceeds in area one-half the effective area of said tympanum; substantially as described.

16

[17.]* A sound regenerator for directly propagating self-sustaining sound waves in air, consisting of a ponder-

ous support having a circular aperture, a light vibratile tympanum exceeding nine inches in diameter having its outer edge mounted on said support; said tympanum being

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[*Words and figures enclosed in brackets erased in copy.]

shaped to provide an annular plane adjacent said support [fol. 92] and a conical portion spring- from the inner edge of said annular plane, and a cap of non-vibratile material rigidly secured to the apex of said conical portion of said tympanum; substantiallly as described.

17.

[18.]* A sound regenerator for directly propagating self-sustaining sound waves in air consisting of a ponderous support having a circular aperture, a light vibratile tympanum mounted in said aperture and having its outer edge secured upon said support, said tympanum being shaped to provide an annular plane adjacent said support and a conical portion springing from the inner edge of said annular plane, the diameter of the base of said conical portion being substantially eight-tenths of the diameter of the said circular aperture in said support, and a cap of non-vibratile material rigidly secured to the apex of said conical portion of said tympanum; substantially as described.

18.

[19.]* A sound regenerator for directly propagating self-sustaining sound waves in air consisting of a ponderous support having a circular aperture, a light vibratile tympanum mounted in said aperture and having its outer edge secured to said support, said tympanum being shaped to provide an annular plane adjacent said support and a conical portion springing from the inner edge of said annular plane, the altitude of said conical portion being substantially one-quarter of the diameter of its base, and a cap of non-vibratile material rigidly secured to the apex of [fol. 93] said conical portion of said tympanum; substantially as described.

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19.

[20.]* A sound regenerator for directly propagating self-sustaining sound waves in air consisting of a ponderous support having a circular aperture exceeding nine inches in diameter, a light vibratile tympanum mounted in said aperture and having its outer edge secured to said support, said tympanum being shaped to provide an annular plane adjacent said support and a conical portion springing from

[*Words and figures enclosed in brackets erased in copy.]

the inner edge of said annular plane, the diameter of the base of said conical portion being substantially eight-tenths of the diameter of the said circular aperture in said support and the altitude of said conical portion being substantially one-quarter of the diameter of its base, and a cap of non-vibratile material rigidly secured to the apex of said conical portion of said tympanum; substantially as described.

[Matter enclosed between rules erased in copy.]

13. [20]*

[21. 17]* In a sound regenerating machine, a vibration transmission comprising two ponderous members, fulcra carried by said members, an articulate parallelogram of links and levers, the levers of said parallelo-
Per A. gram mounted upon said fulcra, pressure exerting means acting between said members and tending through said fulcra to hold said parallelogram under tension, and a style holder carried by one of said levers; substantially as described.

14. [21]*

[fol. 94] [22. 18]* In a sound regenerating machine, a vibration transmission comprising two ponderous members, guides for maintaining the relative positions of said members, fulcra carried by said members, an
Per A. articulate parallelogram of links and levers, the levers of said parallelogram mounted upon said fulcra, pressure exerting means acting between said members and tending through said fulcra to hold said parallelogram under tension, and a style holder carried by one of said levers; substantially as described.

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15. [22 13 19]*

[23.]* In a sound regenerating machine, a vibration transmission comprising two ponderous members, guides for maintaining the relative positions of said members, fulcra carried by said members, an articulate parallelogram of links and levers, the levers of said parallelogram mounted upon said fulcra, pressure exerting means acting

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[*Words and figures enclosed in brackets erased in copy.]

between said members and tending through said fulcra to hold said parallelogram under tension, and a style holder carried by one of said levers; substantially as described.

16. [23 14 20]*

[24.]* In a sound regenerating machine, a vibration transmission comprising two ponderous members, a vertical fulcrum on one of said members, a horizontal fulcrum on the other of said members, an articulate parallelogram of links and levers, the levers [fol. 95] of said parallelogram mounted upon said fulcra, and pressure exerting means acting between said members and tending through said fulcra to hold said parallelogram under tension; substantially as described.

Per A.

17. [24 21]*

[25.]* In a sound regenerating machine, a vibration transmission comprising two ponderous members, fulcra carried by said members, an articulate parallelogram of links and levers, the levers of said parallelogram mounted upon said fulcra, pressure exerting means acting between said members and tending through said fulcra to hold said parallelogram under tension, a style-holder carried by one of said levers, a direct sound regenerating tympanum connected to another of said levers and a pivoted support for said transmission and said tympanum; substantially as described.

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[25 22]*

[26.]* 18. In a sound regenerating machine, a vibration transmission comprising a support, two ponderous members carried by said support, one *as* said members being movable upon said support, insulating material between said movable member and said support, fulcra carried by said members, an articulate parallelogram of links and levers, said levers being mounted on said fulcra and pressure exerting means acting between said members and tending through said fulcra to hold said parallelogram under tension; substantially as described.

26

[fol. 96] [27]* In a sound regenerating machine, a ten-

[*Words and figures enclosed in brackets erased in copy.]

sioned vibration transmission, a style-holder upon one end of said transmission and an untensioned tympanum connected with the opposite end of said tranmission; substantially as described.

27
Per B. [28.]* The combination of a direct sound regenerating machine and a bottomless cabinet therefor, having apertures on all side- affording substantially free paths for the sound waves from the regenerator-containing cavity of the cabinet to the surrounding atmosphere; substantially as described.

[Matter enclosed between rules erased in copy.]

19. [28 23]*

[29.]* In a direct sound regenerating machine, the combination of a bottomless cabinet having apertures on all sides and a horizontal partition therein, a record holder mounted upon and above said partition, a motor for driv-
d
Per B. ing said record holder, a right angle ∧ transmission support mounted to swing upon horizontal and vertical axes upon said partition adjacent and periphery of said record holder, one arm of said support adapted to be swung over said record holder, and the other arm of said support extending downwardly through said partition, a vibration transmission mounted within and insulated from said transmission support and comprising two ponderous members carrying fulcra, a parallelogram

[fol. 97] of links and levers, said levers mounted upon said fulcra, pressure exerting means acting between said members and tending through said fulcra to hold said parallelogram under tension, a style-holder carried by one of said levers at the outer end of said transmission support, a spider mounted upon said transmission support below said partition, a ponderous tympanum support carried by said spider, a direct sound regenerating tympanum mounted upon said ponderous tympanum support, said tympanum

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[*Words and figures enclosed in brackets erased in copy.]

being of light vibratile material and having a conical form throughout the greater part of its area and a positive connection between the apex of the conical portion of said tympanum and the inner end of the parallelogram of the said vibration transmission; substantially as described.

(4)

Insert A3.

[Cls. 20 to 27]

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In testimony whereof I affix my signature, in presence of two witnesses.

Marcus C. Hopkins.

Witnesses: M. A. Bill, Leon W. Rosenthal.

[fol. 98] Oath

Cert. Spec. as Filed 6100

STATE OF NEW YORK,
County of New York, ss:

Marcus C. Hopkins, the above-named petitioner, being duly sworn, deposes and says that he is a citizen of the United States, and resident of Jersey City, County of Hudson and State of New Jersey, and that he verily believes himself to be the original, first and sole inventor of the improvement in sound regenerating machine described and claimed in the annexed specification; that he does not know and does not believe that the same was ever known or used before his invention or discovery thereof, or patented or described in any printed publication in any country before his invention or discovery thereof, or more than two years prior to this application, or in public use or on sale in the United States for more than two years prior to this application; that said invention has not been patented in any country foreign to the United States on an application filed by him or his legal representatives or assigns more than twelve months prior to this application; and that no appli-

cation for patent on said improvement has been filed by him or his representatives or assigns in any country foreign to the United States.

Marcus C. Hopkins.

[fol. 99] Subscribed and sworn to before me this 12th day of July, 1913. M. A. Bill (Signature of Notary Public), Notary Public (Official Character).

Cert. Appln. as filed 6500.

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Div. 23, Room 379

Paper No. 2, Rej.

Address only "The Commissioner of Patents, Washington, D. C."

All communications respecting this application should give the serial number, date of filing, and title of invention.

JHY—Sut.

Department of the Interior, United States Patent Office, Washington

Sept. 9, 1913, U. S. Patent Office. Sep. 9, 1913, Mailed.

Pennie, Davis & Goldsborough, #35 Nassau St., New York, N. Y.:

Please find below a communication from the Examiner in charge of the application of Marcus C. Hopkins, for Sound Regenerating Machine, filed July 14, 1913, serial number 778,826.

E. B. Moore, Commissioner of Patents.

[fol. 100] In the preamble, line 5, a should follow "in."

The matter of the first page of the specification is objected to as lacking in clearness and inaccurate in part. It is not clear what applicant means in the first paragraph, but if he means that a sound box without the aid of a horn will not produce audible sound waves he is clearly wrong. Attention is directed to a common form of phonograph wherein

ear-tubes of uniform diameter lead directly from the sound box. What does applicant mean by "self-sustaining sound waves"? The matter of line 15, and to "air" line 16, is objected to as incorrect. What does applicant mean by "high tension disturbances"?

e''' is e'' on figure 1. g'' is g' on figure 8.

Page 8, lines 7 and 8, why are no wave motions set up in the thin material of the cone?

A formal preamble to the claims should be inserted at the end of page 14.

Claims 1, 2 and 3 are rejected on Miller, June 20, 1905, 793,013, (181-3) or Simon, English patent, July 5, 1904, 15060, (181-3) figure 2. Any graphophone or gramophone of which the examiner is

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aware is a "direct sound regenerating machine" within the ordinary import of the terms used.

Claim 4 is objectionable as claiming the insulation, matter not shown on the drawing. See rule 50.

Claim 4 is rejected on any cabinet talking machine in view of Aiken, Sept. 5, 1911, 1,002,479, (181-9) or Hough, Eng- [fol. 101] lish patent, April 16, 1907, 8833 (181-2).

Claim 5, line 3 "compartment" should be compartments.

Claim 5 is rejected on Shanks, May 29, 1906, 822,024, (181-3), amet, June 23, 1896, 562,753, (181-7), Amet, June 23, 1896, 562,694, (181-7) Repp, Sept. 19, 1911, 1,003,655, (181-7) or Lumiere, Mar. 14, 1911, 986,477, (181-11), figure 7, mounted in any conventional cabinet as Skiff, Mar. 15, 1904, 754,508, (181-3), no invention being found in separating the record and diaphragm spaces by a partition, especially in view of Shields, June 12, 1900, 651,515, (181-2) or Welton, French patent, Feb. 1, 1906, 362,926, (181-3).

Claim 9 is rejected on Repp or Lumiere cited; also as met in terms in Dyer, Dec. 31, 1912, 1,049,215, (181-5), Pumphrey, May 14, 1912, 1,026,178, (181-3) or Macdonald, May 10, 1910, 957,694, (181-3).

Claim 11, line 5, and should follow "arm."

Claim 11 is rejected on Sheble et al., May 3, 1910, 957,004, (181-3), 15 and 10 being the two arms.

Claim 12 is rejected on Rosenthal, English patent, Nov. 17, 1909, 26738, (181-3).

Claim 15 is rejected on Kraemer, June 9, 1908, 890,142, (181-11).

Claim 16 is rejected on Kraemer; English, June 10, 1913, 1,064,062, (181-11); Edison, Feb. 22, 1910, 950,226, (181-10);

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[fol. 102] 778-826——3

Stroh, English patent, Feb. 16, 1901, 3393, (181-10); Brown, English patent, Jan. 16, 1911, 1157, (181-11) or Gaumont & Co, French patent, April 15, 1903, 331,226, (181-10).

Claim 17 is rejected on Kraemer. The size of the di-phragm is not a patentable limitation.

Claim 18 is rejected as not sufficiently distinguished from Kraemer.

Claims 19 and 20 are rejected on Gaumont in view of Kraemer. Note the dimensions of the diaphragm in figure 2 of Gaumont. No invention is found in providing Gaumont's device with a contact piece as at 16 in Kraemer.

Claim 21, line 6, "member" should be members.

Claim 22, line 3, "position" should be positions.

Claim 24, line 5, "lever" should be levers.

Claim 27 is rejected on Gleason, Aug. 11, 1908, 896,006, (181-11), figure 9, Johnson, Sept. 3, 1907, 865, 105, (181-11) figure 5, or Gleason, April 16, 1907, 850,883, (181-11).

Claim 28 is rejected on Simon, Rosenthal or Miller, no invention being displayed over these structures.

J. T. Newton, Ex.

L. H. S.

778,826—28

[fol. 103] Mail Room, Dec. 14, 1913, U. S. Patent Office.

U. S. Patent Office, Received Dec. 26, 1918, Division 23

11783

Div. 23, Paper No. 3

A

Div. 23, Room 379

Application of Marcus C. Hopkins. Sound Regenerating Machine. Filed July 14, 1913. No. 778,826

New York City, N. Y., Dec. 5, 1913.

To the Commissioner of Patents:—

Sir: Replying to the office action of September 9, 1913, please amend the above entitled case as follows:—

In the preamble, line 5, insert "a" after "in."

In Fig. 1 of the drawing, make "e'" "e''."

In Fig. 8 of the drawing, change "g'" to "g''."

At the end of page 14 insert:—

A[1]. "Having thus described my invention, what I claim and desire to secure by Letters Patent, is:—"

Insert commas in the following places on page 1: line 2, after "sounds"; line 5, before "as"; line 9, after "trumpet"; line 16, before "and"; line 17, before "and"; line 18, after "piece"; line 19, after "waves"; line 21, after "reproducer"; line 23, after "disturbances"; line 24, after "air"; line 26, after "losses"; line 28, after "action"; line [fol. 104] 29, after "tension"; and in the following places on page 2:—line 4, after "record"; line 5, after "air"; line 7, after "reproducer" and after "trumpet"; line 8, after "sounds"; line 10, after "making"; line 17, after "record"; line 19, after "transformer"; line 21, after "regenerator"; line 22, after "invention"; line 23, after "air";

line 25, after "record"; line 26, before "in"; line 27, after "waves"; line 28, after "air"; and on page 3, as follows;—

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line 4, before "which"; line 6, after "sounds" and line 11, before "without."

Page 2, line 24, insert a semi-colon before "and."

Page 3, insert semi-colon after "air" in line 7 and after "function" in line 8.

Page 1, line 4, after "propagation" insert | "in free air, | from a record."

Page 1, line 5, cancel "in air from a record."

Page 1, line 7, cancel "which would not be propagated as sound."

Page 1, line 17, after "and" insert | "which." |

Page 1, line 18, after "dissipated" insert "in heat or."

Page 1, line 19, after "waves" insert | "of small volume | and high tension."

Page 1, lines 19 and 20, cancel "or in heat, as is at once apparent" and substitute | "at any considerable distance."

Page 1, lines 21 and 22, cancel "it would appear that."

Page 1, line 26, after "and" insert | "therefore." |

[fol. 105] Page 2, line 1, substitute | "having" | for "with."

Page 2, line 17, cancel "comparatively unknown" and substitute | "not obtained." |

Page 2, line 18, cancel "or" and substitute | "and without." |

Page 2, line 23, cancel "the." first occurrance, and substitute | "unconfined." |

Page 2, line 24, cancel "as such."

Page 2, line 25, change "vibration" to | "vibrations." |

Page 2, line 27, substitute "such a" for "a |proper,"| and insert |"as"| after "tension."

2 778826—30

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Page 2, last line, change "to" first occurrence, to |"in."|
Page 3, line 2, after "wear" insert |"of the record."|
Page 3, line 6, before "imparting" insert |"of."|

It is believed that the foregoing amendments elim-
A. inate the reasons for objection as to lack of clear-
ness and as to inaccuracy.

With reference as to what is meant on page 1 by "self sustaining sound waves," and by "high tension disturbances," it is pointed out that in ordinary phonographs or talking machines, a small diaphragm is mounted in a sound box containing a very small amount of confined air, and all of the energy of the record is projected against this small diaphragm, which is thus violently vibrated, thereby producing air disturbances of so high a tension, that these disturbances cannot, owing to the inertia of air, effect a move-
[fol. 106] ment of a sufficient volume of air to produce sound waves, which, after their production, will be self sustaining so as to carry to a considerable distance and produce sounds which correspond in character, timbre, volume and pitch to the original sounds which made the record, and which, therefore, are the original sounds regenerated.

Inasmuch as these high tension disturbances, which are produced by the small diaphragm in the confined air space of the sound box, cannot, owing to the inertia of air, produce sound waves of large area and of sufficiently low tension suitable for the sound conductivity of air, such sound waves will not be produced as correspond to the sounds which made the record. On the contrary, these high tension disturbances produced by the diaphragm will be squeaky, will have relatively high pitch, and will not be self sustaining so as to carry to any appreciable distance. It is for this

reason that the horn or trumpet is employed to effect a lateral control of these high tension disturbances, resist

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their transformation into heat and convert them into waves of sufficiently low tension and large volume to enable them to overcome the inertia of the air and thereby become self sustained.

But the use of the horn or trumpet amplifies the distortions producer by the small diaphragm being so violently agitated, and introduces distortions due to vibrations set [fol. 107] up in the horn itself. The resultant sound waves are not true reproductions of the original sounds, but are the characteristic sounds known as "phonograph sounds."

In order to obtain faithful reproduction of the original sound waves, that is, to really regenerate the original sounds, applicant has provided a sound regenerating machine which dispenses with the employment of a horn or trumpet for transforming high tension disturbances into waves of lower tension, and in which the vibration of the stylus by the record are mechanically directly transmitted to a diaphragm which is free to vibrate in unconfined air, which has sufficient area to set in motion a large volume of air, which is sufficiently light and rigid to enable it to move in synchronism with the stylus, and the distance of vibration of which is sufficiently short to permit of a relatively slow movement appropriate for the sound conductivity of air, whereby the regenerated sounds will be self sustaining and will be accurate reproductions of the original sounds.

Applicant has thus produced a machine in which the sounds are regenerated directly from the record and in open and unconfined air, without the intervention of a sound box and its confined body of air, and without the intervention of any vibration transforming device, such as a horn or trumpet.

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So far as applicant is aware the machine of this invention is the first which has ever been constructed which will accu-

rately regenerate the original sounds without distortion, [fol. 108] without squeaking, without accentuation of notes of certain pitch, without change in intonation and without any appreciable loss of energy, and which in fact will produce faithful reproductions of the original sounds.

With reference to the statement in lines 7 and 8 of page 8 that no wave motions are set up in the material of the cone portion of the diaphragm, it will be noted that the lower end of the rod V is rigidly secured to the cap M which is secured to the apex of the cone L. The vibrations which are imparted to the cone L through the rod V are mechanical movements which are transmitted directly from the stylus by the levers Q and R and the rods SS and S′. The cone L is therefore moved bodily to and fro and is not molecularly vibrated, the diaphragm not being under tension, as are the transmission rods just referred to. The examiner, of course, understands that the sides of a cone being straight, will not yield when a blow strikes the apex of the cone in the direction of the axis thereof. If the diaphragm were flat where it is connected to the rod V, there would be a local vibration set up in the immediate vicinity of the connecting rod, but a large part of the diaphragm would not be bodily moved, as is the case with the cone, and the resultant sounds would be very feeble, and would not compare in volume to the sounds which are produced by the cone of the applicant's machine. Applicant has demonstrated this practically by employing both flat and conical diaphragms.

[fol. 109]

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With reference to claims 1, 2 and 3 which have been rejected on the patent to Miller No. 793,013, or on the patent (British) to Simon, it will — noted that each of these devices has a small diaphragm located in a sound box provided with a horn and is not a direct sound regenerating machine, in which the regenerated sounds are effected without the intervention of a transforming trumpet or horn, as in applicant's structure.

With machines having sound boxes and horns, it is not material that the cabinet has apertures on all sides, as set forth in claim 1; nor whether it has no bottom as set forth

in claim 2. On the other hand it is of great importance that the cabinet, which contains a direct sound regenerating machine having a diaphragm which impresses its vibrations upon unconfined air, shall have an aperture leading to the surrounding atmosphere, as in claim 3; having no bottom as in claim 2, or having apertures on all sides serving for free path for the sound waves from the compartment containing the regenerator to the surrounding atmosphere, as in claim 1. In machines having sound boxes and horns it is only required that the horn communicate with the outside atmosphere.

The references do not disclose any direct sound regenerating machine mounted in a cabinet, so that it is believed that the patent to Aiken, No. 1,002,479, or the British patent to Hough, No. 8833, of 1907, which show insulation between a machine and a table, the machines being of the ordinary sound box type do not apply to claim 4, which [fol. 110] combines a direct sound regenerating machine with a cabinet in which the machine is mounted and from which it is insulated.

As to claim 5, the provision of a partition between the record table and the tympanum effects a variety of functions. It provides a support for the machine, serves as a

guard for the protection of the diaphragm, which in a machine of this character must be large, exposed to the open air and is liable to injury. At the same time it serves the commercial purpose of enabling a user of a *the* machine to readily put on or take off a record without danger of injury to any of the delicate parts. In the ordinary sound box machine the diaphragm is protected, is close to the record and requires no supporting and protecting partition. None of the references discloses a record table and transmission arm in one compartment and a tympanum located in the other compartment, as specified in claim 5. In the French to Welton, No. 362,926 and the patent to Shields, No. 651,515, cited to show a partition separating the record table and the diaphragm, the record on the diaphragm are both in the same chamber. In neither one of these devices is there any partition between the record table and the tym-

panum. All that these two devices show, with reference to a partition is a trumpet leading from one chamber to the outside thereof.

[fol. 111] Cancel "compartment" and substitute | "compartments," | in line 3 of claim 5. Insert a comma before "of" in line 2 of said claim.

Cancel claim 9.

Claim 10, line 1 insert a comma after "machine." Insert a comma after "support" in line 3.

Claim 11, insert a comma after "machine" line 1, and after "holder," line 2. Line 5 after "and," | insert A^2. adapted to carry a stylus, the support having. Same line, before "a tympanum" insert | "and." | Same line cancel "by" and substitute "at the free end of."

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Claim 11, as amended, distinguishes from the patent to Sheble et al, cited, in being restricted to a direct sound regenerating machine, with the diaphragm carried at the free end of the second arm, while in the reference the diaphragm is carried at the junction between the arms and the machine is of the sound box type having a transforming horn.

The British patent to Rosenthal No. 26,738 is not a direct sound regenerating machine, as specified in claim 12 but is a sound box machine having a horn, which closes an opening in the bottom of the cabinet and the tympanum is not directed downwardly as in applicant's construction. In the reference the diaphragm is not free to vibrate in the open air and direct sound waves unrestricted and without transformation through an opening in the bottom of the cabinet.

[fol. 112] Each of the claims 15 to 20 inclusive is drawn to the combinations of elements therein set forth as combined in a sound regenerator for directly propagating self sustaining sound waves in air. Each of the devices of the references is an ordinary reproducer having a small diaphragm operating in a sound box having a small volume of confined air, and requiring, in order to set up self sustaining

waves, the intervention of a transforming device, such as a horn or trumpet, to change the high tension vibrations into lower tension waves of greater amplitude. No one of the diaphragms described and illustrated in the said references can be employed to directly propagate and regenerate the original sounds, but, the sounds produced therewith will be of high pitch and of so great a tension that the disturbances will not set up self sustaining waves in the air, for the reasons hereinbefore given.

For these reasons the references cited against claims 15 to 20 inclusive do not meet the claims. With reference to claims 17 which specifies a tympanum exceeding 9 inches in diameter, it is submitted that the size of the tympanum is what enables it to effect direct regeneration of the sound. When a horn is employed for transforming high tension disturbances, the size of the tympanum is immaterial. Applicant has practically demonstrated that, to effect direct regeneration from the record of the sounds, a light, vibratile [fol. 113] tympanum of substantially 9 inches in diameter or greater must be employed in order to obtain faithful reproductions. With respect to claim 15, there is no apex to the diaphragm of Kraemer, No. 890,142, the plate 16, Fig. 3, being secured to the flat central portion of the diaphragm, which is not a cone as in applicant's construction, but is a frustum of a cone with a flat top, which is considerably larger than the metal plate 16. With a diaphragm of this kind, the center will yield and produce local disturbances. Furthermore the conoidal portion of the Kraemer device, not terminating in an apex, and the plate 16 not reaching to the conoidal portion, said conoidal portion will not be moved bodily to the same extent as would be the case if the metal plate were secured to an apex, as in applicant's construction.

As has already been pointed out, the Kraemer device is a sound box employing a horn and cannot directly regenerate self sustaining sound waves without the employment of the trumpet, while claims 15 to 20 inclusive are drawn to a direct sound regenerator.

Claim 18 distinguishes from Kraemer in the same manner as does claim 15, the cap being secured to the apex of a cone, while in the Kraemer device the cap is secured to the flat top of the frustum of a cone, the top being of greater diameter than the cap.

Claims 15, 17, 18, 19 and 20 each distinguishes from Kraemer in the cap being secured to the apex of a cone. [fol. 114] The dimensions of the diaphragm and of the conical portion thereof, as set forth in claims 15 to 20 inclusive, are essential elements in a direct sound regenerator, but they are not essential in sound boxes which employ horns or trumpets as do all of the references which have been cited against these claims. This has been demonstrated by the applicant by actual trial.

For the foregoing reasons it is submitted that claims 15 to 20 inclusive are not met by the references.

Claim 16, line 2, change "og" to "of."

Claim 21, line 6, change "members" to | "members." |

Claim 22, line 3, change "position" to | "positions." |

Claim 24, line 5, change "lever" to | "levers." |

Claim 26, last line, change "tention" to | "tension." |

Claim 27 distinguishes from the references in being drawn to a structure having an untensioned diaphragm, while the devices of the references have tensioned diaphragms as set forth in lines 15 to 18, page 1 of the Gleason patent, No. 850,883. Claim 27 further distinguishes in the untensioned diaphragm being connected at the end of the tensioned transmission, while in the references the diaphragm is connected intermediate of the ends of the tensioned members.

In the Gleason and Johnson patents, the tension serves only to retain the knife edges seated, and the tension serves to resist the vibration of the stylus. In applicant's struc- [fol. 115] ture, the tension does not interfere at all with the free vibration of the stylus, but is in a direction parallel

with the direction of movement of the stylus. For this reason the tympanum is connected at one end of the ten-

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sioned transmission, in applicant's structure, instead of intermediate of and at right angles to the direction of tension as in the devices of the references.

With reference to claim 28 rejected on Simon, Miller or Rosenthal, it will be noted, as was stated with reference to claims 1 to 3, that the references are all sound box machines which require horns to regenerate the sound waves, and in such structures it is not material whether or not the cabinet is bottomless and has apertures in all of its sides for affording free paths for sound waves to the surrounding atmosphere, as set forth in claim 28, but it is of importance in a direct sound regenerating machine, for the success of such a machine is dependent upon the free vibration of a large diaphragm in unconfined air.

Furthermore, none of the references is provided with a bottomless cabinet nor with apertures on all sides, as set forth in the claims. Simon's machine rests on a table or base, and is not provided with any cabinet. The cabinets of Rosenthal and Miller have no openings on all sides, and each has a bottom provided with an opening which is closed by a horn.

Relative to the criticism in con-ection with claim 4, that the drawings do not illustrate insulation between the re- [fol. 116] generator and the cabinet, attention is directed to Fig. 3, in which there is shown insulation i' between the regenerator and the cabinet.

For the foregoing reasons favorable reconsideration of the rejected claims is requested.

Change the ordinals of claim 10 and the claims following.

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11794

[Please add to the claims the following claims:]*

20.

[24, "29.]* In a sound regenerating machine, a tympanum, a vibration transmission tensioned in the direction

[*Words and figures enclosed in brackets erased in copy.]

of its vibration independently of the tympanum and connected therewith, and a style holder connected with said transmission."

21.

[25, "30."] In a sound regenerating machine, an untensioned tympanum, a vibration transmission tensioned in the direction of its vibration and connected with said tympanum, and a style holder connected with said transmission."

22.

[26, "31."] In a sound regenerating machine, a tympanum, an oscillatory transmission member connected therewith, a style holder for oscillating the transmission member, and means independent of the tympanum for tensioning the transmission member in the direction of its oscillatory movement."

23.

[27, "32."] In a sound regenerating machine, a tympanum, an oscillatory transmission member connected [fol. 117] therewith, a style holder for oscillating said member, and means independent of the tympanum for yielding imparting a tension to said member in the direction of its oscillatory movement."

24.

[28, "33."] In a sound regenerating machine, an untensioned tympanum, a transmission member connected therewith and adapted for oscillation, a style holder for oscillating said member, and means for imparting a tension to said member in the direction of its oscillatory movement."

[Cl. 25 follows]

"34. In a sound regenerating machine, a tympanum, an oscillatory transmission member connected therewith, a style holder for oscillating said member, and means for tensioning said member without affecting its freedom of movement."

Per B.

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"35. In a sound regenerating machine, a style holder, a tympanum, and transmission means under tension connect-

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[*Words and figures enclosed in brackets erased in copy.]

ing the style holder and tympanum, the freedom of movement of the style holder being unaffected by said tension."

"36. In a sound regenerating machine, an oscillatory style, a tympanum, and longitudinally rigid transmission and arranged to impart to the tympanum vibrations means connecting the style and tympanum / which have less length than the vibrations of the style."

[fol. 118] "37. In a sound regenerating machine, an oscillatory style, a tympanum, and tensioned trans-
A². mission means connecting the style and tympanum and arranged to impart vibrations to the tympanum which have less length than the vibrations of the style."

"38. In a sound regenerating machine, an oscillatory style, a tympanum, and tensioned transmission means connecting the style and tympanum and arranged to impart vibrations to the tympanum having less length than the vibrations of the style, the tension of the transmission being in the direction of its vibration."

25.

[39, 29.]* In a sound regenerating machine,
D⁴. a tympanum $\wedge_{D4}$ having a free area exceeding nine
Per F. inches in diameter and having a portion substantially eight-tenths of the diameter of said free area which is rigid in the direction of the axis of the tympanum."

26.

[30, "40."]* In a sound regenerating machine, a
D⁴. typanum $\wedge_{D4}$ having a free area exceeding nine inches in diameter and having a conical portion substantially eight-tenths of the diameter of said free area."

[fol. 119] 11796

27.

[31, "41."]* In a sound regenerating machine, a
D⁴. tympanum $\wedge_{D4}$ having a free area exceeding nine

[*Words and figures enclosed in brackets erased in copy.]

inches in diameter and having a conical portion substantially eight-tenths of the diameter of said free area, the altitude of said conical portion being substantially one-quarter of the diameter of its base."

"42. In a sound regenerating machine, an oscillatory style, a tympanum having a relatively rigid vibratory portion, and longitudinally rigid transmission means connecting the style and the rigid portion of the tympanum and arranged to impart vibrations thereto having less length than the vibrations of the style."

"43. In a sound regenerating machine, an os-
A². cillatory style, a tympanum having a conical vi-
bratory portion, and transmission means con-
Per B. necting the style with said conical portion and
arranged to impart thereto vibrations having less length than the vibrations of the style."

"44. In a sound regenerating machine, a style holder, a tympanum having a relatively rigid vibratory portion, and a tensional transmission connecting the style holder with said rigid portion, the freedom of movement of the style holder being unaffected by the tension of the transmission."

"45. In a sound regenerating machine, a style holder, a tympanum having a conical vibratory portion, and a tensioned transmission connecting the style holder and said [fol. 120] conical portion, the freedom of movement of the style holder being unaffected by the tension of the transmission."

[Matter enclosed between rules erased in copy.]

25.

[28, 32, "46."]* In a sound regenerating machine, a style holder, a tympanum having a rigid vibratory portion, and a tensioned transmission connecting the style holder with said rigid portion, the tension of said transmission being in the direction of its vibration and independent of the tympanum."

[*Words and figures enclosed in brackets erased in copy.]

[Cl. 26 follows.]

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11797

"47. In a sound regenerating machine, a style holder, a tympanum having a conical vibratory portion, and a tensioned transmission connecting the style holder with said conical portion, the tension of said transmission being in the direction of its vibration."

"48. In a sound regenerating machine, a style holder, an untensioned tympanum having a rigid vibratory portion, and a tensioned transmission connecting the style holder with said rigid portion."

A^2. "49. In a sound regenerating machine, a style holder, an untensioned tympanum having a conical vibratory portion, and a tensioned transmission connecting the style holder with said conical portion."

Per B. "50. In a sound regenerating machine, a style, a tympanum, and longitudinally rigid transmission means connecting the style and tympanum and having means for imparting vibrations to the tympanum having no greater length than the vibrations [fol. 121] of the style."

"51. In a sound regenerating machine, a style, a tympanum, and tensioned transmission means connecting the style and tympanum and having means for imparting vibrations to the tympanum having no greater length than the vibrations of the style."

"52. In a sound regenerating machine, a style, a tympanum, and tensioned transmission means connecting the style and tympanum and having means for imparting vibrations to the tympanum having no greater length than the vibrations of the style, the tension of said transmission being independent of te tympanum."

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"53. In a sound regeneratng machine, a style, a tympanum, and tensioned transmission means connecting the

style and tympanum, and having means for imparting vibrations to the tympanum having no greater length than the vibrations of the style, the tension of said transmission being independent of the typmpanum."

[Matter enclosed between rules erased in copy.]

26.

[29 33 "54.]* In a sound regenerating machine, a style, a tympanum, and tensioned transmission means connecting the style and tympanum and having means for imparting vibrations to the tympanum having no greater length than the vibrations of the style, the tension of said transmission being in the direction of its vibra-

A[23]. [fol. 122] tions and independent of the tympanum."

[Cl. 27 follows.]

"55. In a sound regenerating machine, a style, an untensioned tympanum, and transmission means connecting the style and tympanum and having means for imparting vibrations to the tympanum having no greater length than the vibrations of the style."

"56. In a sound regenerating machine, a style, an untensioned tympanum, and tensioned transmission means connecting the style and tympanum and having means for imparting vibrations to the tympanum having

Per. B. no greater length than the vibrations of the style."

"57. In a sound regenerating machine, a tympanum having a conical vibratory portion adapted to be vibrated from a record, the tympanum having a vibratile area of sufficient size to effect, without amplification, the regeneration from the record of sound waves of relatively large volume and carrying power."

"58. In a sound regenerating machine, a style, a tympanum and longitudinally rigid transmission means connecting the style and tympanum and having means for im-

parting vibrations to the tympanum having no greater length than the vibrations of the style, the tympanum hav-

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[*Words and figures enclosed in brackets erased in copy.]

ing a vibratile area of sufficient size to effect, without am-
[fol. 123] plification, the regeneration of sound waves of relatively large volume and carrying power."

"59. In a sound regenerating machine, a style, a tympanum, and longitudinally rigid transmission means connecting the style and tympanum and having means for imparting vibrations to the tympanum having less
A². length than the vibrations of the style, the tympanum having a vibratile area of sufficient size to effect, without amplification, the regeneration of sound waves of relatively large volume and carrying power."

"60. In a sound regenerating machine, a tympanum having a rigid vibratory portion adapted to be vibrated from a record, the tympanum having a vibratile area of sufficient size to effect, without amplification, the regeneration from the record of sound waves of relatively large volume and carrying power, and longitudinally rigid means connected with said rigid portion for transmitting thereto vibrations of a style."

"61. In a sound regenerating machine, a tympanum having a conical vibratory portion adapted to be vibrated from a record by a style, the tympanum having a vibratile area of sufficient size to effect, without amplification, the regeneration from the record of sound waves of relatively large volume and carrying power, and transmitting means connected with said conical portion and adapted to be actuated by a style."

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11800

[fol. 124] "62. In a sound regenerating machine, a tympanum having a vibratile area of sufficient size to effect, without amplification, the regeneration from a record of sound waves of relatively large volume and carrying power, and tensioned vibration transmitting means connected to the tympanum and adapted to be actuated by a style, the tension thereof not extending to the tympanum."

[Matter enclosed between rules erased in copy.]

27.

[30 34 "63."]* In a sound regenerating machine, a tympanum having a vibratile area of sufficient size to effect,

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[*Words and figures enclosed in brackets erased in copy.]

without amplification, the regeneration from a record
A². of sound waves of relatively large volume and carrying power, and tensioned vibration transmitting means connected to the tympanum and adapted to be actuated by a style, the tension of the transmission being in the direction of its vibration and not extending to the tympanum."

Insert B⁶.
Cl. 28.

"64. In a sound regenerating machine, a tympanum having a rigid vibratory portion, the tympanum having a vibratile area of sufficient size to effect, without amplification, the regeneration from a record of sound waves of relatively large volume and carrying power,
Sub. B⁶. and tensioned vibration transmitting means connected to said rigid portion and adapted to be actuated by a style, the tension thereof not extending to the tympanum."

"65. In a sound regenerating machine, a tympanum having a conical vibratory portion and having a vibratile area of sufficient size to effect, without amplification, the regeneration from a record of sound waves of relatively large [fol. 125] volume and carrying power, and tensioned vibration transmitting means connected to said conical portion and adapted to be actuated by a style."

"66. In a sound regenerating machine, a style holder having an axis which, when the style carrier thereby is in operative contact with the record, is substantially perpendicular to the record."

"67. In a sound regenerating machine, a style holder having an axis which, when the style carried thereby is in operative contact with the record, is substantially perpendicular to the record, the style holder having means for holding the style at an inclination to the axis."

[Matter enclosed between rules erased in copy.]

Claims 29 to 33 and 38, 46, 47, 52, 54 and 63 distinguish from the references in the tension of the transmission being in the direction of the vibration thereof. By this construction the freedom of movement of the transmission by the style is not affected. In the devices of the Gleason and Johnson, cited as showing tensioned transmission, the tension is in a direction transverse to the vibrations of the style. It will be understood that in such constructions the tension of the transmission resists free movement of the style.

Claims 34, 35, 44, 45, 46 and inclusive distinguish from the references in the feature of the tension of the transmis- [fol. 126] sion means not interfering with the free movement of the style. As above stated, the tension of the Gleason and Johnson devices does not interfere with the free movement of the style.

Claims 30, 33, 48 49, and 56 distinguish from the references in the combination with a tension transmission of an untensioned tympanum. In the references having tensioned transmission, the tympanum is tensioned thereby.

Claims 31, 32, 46, 53, 54, 62, 63 and 64 distinguish from the references in the tensioned transmission which does not extend to the tympanum. This is also true of claim 29.

Claims 36, 37, 38, 42, 43 distinguish from the references in the arrangement by which the tympanum has a less length of vibration than the style. In the references the leverage is the other way, the style holder being pivoted with the style at the shorter end of the lever, whereby the length of vibration of the diaphragm is greater than the length of

vibration of the style. This makes great wear on the record and distorts the sound waves.

With small diaphragms, such as are used in sound boxes, a large amount of vibration is imparted to the diaphragm to compensate for the small amount of air moved. Such a large movement of the diaphragm produces high tension disturbances due to the rapid movement of the diaphragm in its traveling the distance which it is required to travel

during each vibration. The inertia of the air prevents its partaking bodily of these high tension disturbances, so it [fol. 127] becomes necessary to confine them and transform them, by means of a trumpet, into waves of less tension and larger volume to which the air can respond and thereby produce waves of large volume and carrying power and which are self-sustaining.

Applicant eliminates the production of high tension disturbances which require transformation by a horn, and employs a diaphragm having a vibratile area of sufficient size and small range of movement to effect, when vibrated, the regeneration directly, without amplification, and without the use of a horn or sound box, waves which are self-sustaining by reason of their large volume and carrying power. The employment of a large diaphragm moved but a small distance in each vibration reduces the distortions, and permits the style to exert great leverage in vibrating the diaphragm, thereby reducing the wear on the record.

What is meant by "high tension disturbances" may be illustrated as follows: If a paddle be moved flatwise rapidly back and forth in water, at a rate of speed such that the inertia of the water will not permit it to respond, only violent local disturbances will be produced which will not carry to any considerable distance. On the other hand, if the paddle be larger and of considerable area and be moved

back and forth slowly enough for the water to respond, waves of large volume and carrying power will be produced. These two instances, of the use of the small paddle moved [fol. 128] rapidly to and fro for a considerable distance and thereby producing only local disturbances, not capable of generating waves of large volume and carrying power; and the use of a large paddle moved a less distance in the same length of time, and therefore more slowly, and generating waves of large volume and great carrying power, are analogous respectively to the small violently agitated diaphragm of the ordinary sound box and horn phonograph, and applicant's structure, which employs a large relatively slow moving and slightly vibrated diaphragm, which vi-

brates in unconfined air, thus generating sound waves which are "self-sustaining," and which eliminates the sound box and horn and the distortions which accompany their use.

Claims 50 to 56 inclusive and 58, 59 and 60 distinguish from the references in the transmission means which imparts vibrations to the tympanum of no greater length than the vibrations of the style.

Claims 39, 40, 41, 57, 61 and 65 distingunsh from the references in the conical tympanum having a vibratile area of sufficient size to effect, without amplification, the regeneration from the record of sound waves of large volume and carrying power. Each of the references having a conical diaphragm, is of the sound box type having a small tympanum with a range of vibrations greater than that of the stylus and which requires a sound box and horn to transform the high tension disturbances produced into waves to which the air can respond.

Claims 36, 42, 50, 58, 59 and 60 distinguish from the references in the transmission means being longitudinally rigid. This feature is of great importance in direct sound regenerating machines, where the reduction in length of vibration of the tympanum, relative to the stylus, is effected, as specified in the first five of these claims. By having a longitudinally rigid transmission, the vibrations from the style are transmitted to the diaphragm without loss by means of loose joints or by absorption, as would occur with a longitudinally flexible transmission.

Claims 66 and 67 distinguish from the references in the axis of the style holder being substantially perpendicular to the record, when the style is in the operative position on the record. In the references, the axes are either parallel with the surface of the record, or disposed at an inclination thereto. By having the axis substantially perpendicular, the style travels in a plane transversely in the record groove, which is the proper movement, instead of moving in a curve transversely in the record, as it does in the devices of the references.

For the foregoing reasons favorable reconsideration of the rejected claims, and favorable consideration of the new claims is requested.

Annexed hereto find supplemental oath.

Respectfully submitted.

Pennie, Davis & Goldsborough, Attorneys for Marcus C. Hopkins.

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[fol. 130] 11806

Supplemental Oath

STATE OF NEW YORK,
County of New York, ss:

Marcus C. Hopkins, whose application for letters patent for an improvement in Sound Regenerating Machines, serial number 778,826, was filed in the United States Patent Office on or about the 14th day of July, 1913, being duly sworn, deposes and says that the subject matter of the foregoing amendment was part of his invention, was invented before he filed his original application, above identified, for such invention, was not known or used before his invention, was not patented or described in a printed publication in any country more than two years before his application, was not patented in a foreign country on an application filed more than twelve months before his application, was not in public use or on sale in this country for more than two years before the date of his application, and has not been abandoned.

Marcus C. Hopkins.

Subscribed to and sworn before me this 22 day of December, 1913. M. A. Bill, Notary Public for and in Kings County, New York. Certificate filed in N. Y. Co. Notary No. 48.

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[fol. 131] 2—26

Div. 23, Room 379

Paper No. 4

Address only "The Commissioner of Patents, Washington, D. C.," and not any official by name.

All communications respecting this application should give the serial number, date of filing, title of invention, and name of the applicant.

LCE—Su.

Department of the Interior, United States Patent Office, Washington

Feb. 7, 1914. U. S. Patent Office. Feb. 7, 1914, Mailed.

Pennie, Davis and Goldsborough, 35 Nassau Street, New York, N. Y.:

Please find below a communication from the Examiner in charge of the application of Marcus C. Hopkins, for Sound Regenerating Machine, filed July 14, 1913, Serial No. 778,826.

Thomas Ewing, Commissioner of Patents.

In response to amendment of Dec. 24, 1913.

"e" " has been changed on Fig. 1 to e"', instead of as directed on page 1 of the above noted amendment.

Page 1, lines 15 and 16, "the —— air" is objected to as not true as broadly as stated, for the reasons of record. What authority has applicant for the use of "high tension" and "low tension" in connection with sound waves?

[fol. 132] Claim 1 is rejected on Miller or Simon of record for the reasons of record, as not distinguishing therefrom. "Direct sound regenerating machine" is held to be too vague and indefinite to distinguish from the ordinary talking machine which is broadly such a machine. Nor is invention found in mounting Lumiere of record in a cabinet with provision for sound outlet on all sides, if such is desired.

Claim 2 is rejected on the references and the reasons of record; also as involving no invention in mounting Lumiere is a bottomless cabinet.

Claim 3 is rejected on the references and reasons of record; and also on Lumiere mounted in any conventional cabinet as Skiff et al., of record.

Claims 4 and 5 are rejected on the references for the reasons of record.

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Claim 6 is rejected as specifying only.

Johnson, 1,015,321, Jan. 23, 1912, (181-3), note 12, with the end partition extended to separate the record compartment from a sound conduit compartment, as in Shields or Welton of record, or in

German patent, 220,412, Mar. 26, 1910, (181-3).

Claim 7 is rejected as specifying no more than the device in

Persichetti, French patent, 397,609, May 13, 1909, (181-3), with a diaphragm at the mouth of the horn, as in

Szek et al., English patent, 8,011, Apr. 3, 1906, (181-27).

Claims 8 and 9 are rejected on Persichetti and Szek, no [fol. 133] invention being found in flaring the mouth of the horn in the former as in the latter.

Claim 10 is objectionable in that it is not positively expressed that the second arm has a free end. Claim 10 is rejected on Johnson above cited. 4 and 7 are the two arms. It is patentably immaterial whether 12 is carried by 7 or 8.

Claim 11 is rejected on Rosenthal of record.

Claims 12 and 13 are allowed.

Claim 14 is rejected as no invention is found in interposing any of the common non-vibratile members employed in this art between the diaphragm and stylus bar as in

Kraemer, 885,490, Apr. 21, 1908, (181—11),
Montgomery, 652,800, July 3, 1900, (181—11),
Hill, 668,183, Feb. 19, 1901, (181—10), or
Berliner, 534,543, Feb. 19, 1895, (181—3)

between the diaphragm and stylus bar of any such structures as in Gaumont, English, Edison, Browne, or Stroh, all of record.

Claim 15 is rejected on the references and for the reasons of record.

Claim 16 is rejected on the references and reasons of rejection of claim 14. The size of the diaphragm is held not a patentable limitation. Note, however, that Lumiere discloses a diaphragm exceeding nine inches in diameter.

Claims 17, 18 and 19 are rejected upon Gaumont of record, in connection with the considerations above given.

[fol. 134] Claims 20 to 25 inclusive are allowed.

Claim 26 is rejected on the references of record. As the tension means acts in the plane of the bar and in the direction of the fulcrum, it is believed it will not tension the diaphragm in these several structures. This claim is also rejected on English, 940,795, Nov. 23, 1909 (181—11), note spring 22.

Claim 27 is rejected on the references of record and also on the additional grounds of rejection of claims 1 and 2.

Claim 28, line 5, "angle" should be —angled—. This claim is otherwise allowable.

Claims 29 to 33 inclusive, 46, 54, and 63 are allowable, as at present advised.

Claims 34, 35, 44 and 45 are objectionable as inaccurately descriptive in the statement that the freedom of movement of the style holder is unaffected by the tension of the transmission. The friction of the moving parts will obviously be increased with the pressure.

Claims 34, 35 and 44 are rejected on the grounds of rejection of claim 26.

Claims 36 and 55 are rejected on any of the following references:

Edison, 703,774, July 1, 1902, (181-10),
Betzold, 633,226, Sept. 19, 1899, (181-11),
Jones, 750,460, Jan. 26, 1904, (181-11), Figs. 1 to 3,
Schwartz, 875,853, Jan. 7, 1908, (181-11), or
German patent, 183,685, Apr. 25, 1907, (181-11)

Claims 37, 51, 53 and 56 are rejected on the references last cited in view of the references cited against claim 26.

[fol. 135] Claim 38 is rejected as no invention is found in tensioning the transmission in any of the references cited against claim 36, in view of the cited art. Thus no invention is found in tensioning Jones' stylus bar as in Berens, 890,754, June 16, 1908 (181—11).

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Claim 39, 40 and 41 are rejected on Gaumont or English, 1,064,062, in view of Lumiere, the selection of the particular dimensions being held not a matter of invention in the absence of a showing of novel results arising from the par-

ticular dimensions and such as could not be obtained by the ratio of dimensions of the references.

Claims 42 and 43 are rejected on Gaumont or English last cited in view of the references cited against claim 36.

Claim 45 is rejected on any of the references cited against claim 26 in view of any conical diaphragm in the art.

Claim 47 is rejected on any conical diaphragm as in Gaumont or English, 1,064,062, in view of any such tension means as in Berens.

Claims 48 and 49 are rejected on any conical diaphragm mounted in the references cited against claim 26.

Claim 50 is rejected on any of the references cited against claim 36 or Edison, 705,829, July 29, 1902 (181—11).

[fol. 136] Claim 52 is rejected on any of the references cited against claim 36, in view of any such tension means as in Berens.

Claim 57 is rejected on Lumiere; also on any conical diaphragm cited in view of Lumiere.

Claim 58 is rejected on the grounds of rejection of claim 57, the longitudinally rigid transmission means being the common form in this art, as in references cited, and no invention being found in actuating any of the cited diaphragms by such means.

Claim 59 is rejected on the references and the reasons last given, no invention lying in using a reducing lever in view of the art cited against claim 36.

Claim 60 is rejected on any conical diaphragm as English, 1,064,062, in view of Lumiere.

Claim 61 is rejected on the grounds given against claim 57.

Claim 62 is rejected on Lumiere in view of any of the references against claim 26.

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Claims 64 is rejected on the grounds of rejection of claim 60 in view of any of the references cited against claim 26.

Claim 65 is rejected on the grounds of rejection of claim 64, or on the grounds of rejection of claim 60, in view of any of the tensioning means cited.

Claims 66 and 67 are rejected on

Shue, 842,028, Jan. 22, 1907, (181-11),
English, 1,001,004, Aug. 22, 1911, (181-11), or
Lyons, English patent, 15,675, June 29, 1910, (181-11).

[fol. 137] The claims in this case are many times too numerous for the scope of applicant's invention, and should be reduced to not over twenty.

W. D. Groesbeck, Exr.

L. H. S.

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#5

Div. 23

"B"

Div. 23—Room 379

United States Patent Office

Application of Marcus C. Hopkins. Filed July 14, 1913. Serial No. 778,826. Sound Regenerating Machine

New York, February 5, 1915.

The Honorable Commissioner of Patents, Washington, D. C.

SIR: In response to Office Action of February 7th, 1914, please amend as follows:

On page 1 of the specification, line 5, after "waves" insert—substantially corresponding to the original
B[1]. recorded sounds in intensity or amplitude as well as in pitch and timbre,—; lines 11 and 12, cancel "self-sustaining" and substitute—such regenerated. Lines 15 and and 16 cancel "self-sustaining" and substitute—such—. [fol. 138] In line 19 strike out the amendment inserted after the word "waves," and which reads "of small volume and high tension." In line 23 cancel "high tension" and substitute—relatively violent—. In line 25, after "conducting" insert—such—and after "disturbances" strike out "of such tension." In the last line strike out "tension" and substitute—violence of the disturbances—.

On page 2, in line 1, change "tension" to—movement—. Cancel the last two lines of page 2, and the first two
B[2]. lines of page 3, and substitute—directly in the free air surrounding it sound waves of an intensity or

amplitude substantially corresponding to the original recorded sound waves. In other words, the original sounds

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are directly regenerated by the vibrating tympanum without the interposition of a restrictive or sound modifying transformer.

On page 6, in the last line, after "portion" insert—or supporting rim—.

B³. On page 7, in line 7, strike out "called for by the correla," and strike out lines 8, 9 and 10, and line 11 through the period, and substitute—/which are required to regenerate the sound waves in the manner above described.

On page 8 in the last line, change the comma before "but" [fol. 139] to a period, and strike out the remainder of the line, and the first five lines and line 6, through the period, on page 9.

On page 9, in line 15; strike out "It is prob-" and strike out lines 16 to 28 inclusive, constituting the remainder of the paragraph.

Cancel claims 1 to 4, inclusive, and substitute therefor the following:

1. In a machine for directly regenerating
C¹. G². sound from a record of the same ∧, a vibra-
[C¹]*
Insert D¹. tile conical tympanum ∧, and a mechanical
[D¹]*
B⁴. transmission through which the vibrations produced by the record are transmitted to the tympanum, the tympanum being of sufficient area to impart to the surrounding free air, when the tympanum is so vibrated, sound waves substantially corresponding in intensity to the recorded sound waves; substantially as described.

[*Words and figures enclosed in brackets erased in copy.]

2. In a machine for directly regenerating
C^1. sound from a record of the same $_\wedge$, a vibra-
Insert G^x. [C^1]*
D^1. tile conical tympanum $_\wedge$, a mechanical trans-
[D^1]*
mission through which the vibrations produced by the record are transmitted to the tympanum, the tympanum being of sufficient area to impart to the surrounding free air, when the tympanum is so vibrated, sound waves substantially

corresponding in intensity to the recorded sound waves, [fol. 140] and an open-work cabinet inclosing the tympanum but affording substantially free access of the surrounding air thereto; substantially as described.

Change the number of claims 5, 6, 7, 8, 9, and 10 to 3, 4, 5, 6, 7 and 8, respectively. Cancel claim 11 and change the numbers of claims 12 and 13 to 9 and 10.

In claim 8 old claim 10, in line 5, after "arm" insert—having a free end—.

Cancel claims 14 to 19, inclusive, and substitute therefor the following:

7. [11.]* In a machine for directly regenerat-
D. G^x. ing sound from a record of the same $_\wedge$, a tym-
C^1. [C^1]*
panum support having a circular aperture, a
of long area
B^5. light vibratile tympanum $_\wedge$ having its outer
rigidly
edge $_\wedge$ mounted in said support, said tympanum being shaped to provide an annular sustaining rim adjacent said support, and a conical portion springing from the inner edge of said annular rim, a cap of non-vibratile material rigidly secured to the apex of said conical portion of said tympanum, and a mechanical transmission through which the vibrations produced by the record are transmitted

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[*Words and figures enclosed in brackets erased in copy.]

to the tympanum, the tympanum being of sufficient area to impart to the surrounding free air, when the tympanum is so vibrated, sound waves substantially corresponding in intensity to the recorded sound waves; substantially as described.

[fol. 141] 8. [12].* In a machine for directing " G^x. regenerating sound from a record of the same $\wedge$, D. [C^1]*

a ponderous tympanum support having a circular of long area

D^2. aperture, a light tympanum $\wedge\wedge$ mounted upon said D2

support in said aperture, said tympanum having a central conical portion, the base of which exceeds in area one half the effective area of the said tympanum and

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a mechanical transmission through which the vibrations produced by the record are transmitted to the tympanum, the tympanum being of sufficient area to impart to the surrounding free air; when the tympanum is so vibrated, sound waves substantially corresponding in intensity to the recorded sound waves; substantially as described.

" 9. [13.]* In a machine for directly regenerat-

C^1 G^x. ing sound from a record of the same $\wedge$, a ponder- [C^1]*

ous tympanum support having a circular aperture, a light vibratile tympanum exceeding nine inches in diameter, rigidly

D. having its outer edge $\wedge$ mounted on said support, said tympanum being shaped to provide an annular rim adjacent said support, and a conical portion springing from the inner edge of said annular rim, a cap of non-vibratile material rigidly secured to the apex of said conical portion of said tympanum, and a mechanical transmission through [fol. 142] which the vibrations produced by the record are transmitted to the tympanum, whereby the tympanum imparts to the surrounding free air sound waves substantially corresponding in intensity to the recorded sound waves; substantially as described.

[*Words and figures enclosed in brackets erased in copy.]

10. [14.]* In a machine for directly regenerat-
G^x " ing sound from a record of the same ∧, a ponderous
[C^1]*
support exceeding nine inches in diameter
tympanum ∧ having a circular aperture ∧, a light vibratile tympanum mounted in said aperture and having its outer
rigidly
" edge ∧ secured upon said support, said tympanum being shaped to provide an annular rim adjacent said support, and a conical portion springing from the inner edge of said annular rim, the diameter of the base of said conical portion being not less than eight-tenths of the diameter of the said circular aperture in said support, a cap of non-vibratile material rigidly secured to the apex of said conical portion of said tympanum, and a mechanical transmission through which the

vibrations produced by the record are transmitted to the tympanum, the tympanum being of sufficient area to impart to the surrounding free air, when the tympanum is so vibrated, sound waves substantially corresponding in intensity to the recorded sound waves; substantially as described.

[fol. 143] 11. [15.]* In a machine for directly
G^x C^1. regenerating sound from a record of the same ∧,
[C^1]*
a ponderous tympanum support having a circu-
of long area
D. lar aperture, a light vibratile tympanum ∧
mounted in said aperture, and having its outer
rigidly
edge ∧ secured to said support, said tympanum
D^3. being shaped to provide ∧ [an annular rim ad-
Insert G^1.
jacent said support.]* ∧ [and a conical por]* tion
[D^3]*
springing from the inner edge of said annular rim, the altitude of said conical portion being substantially one fourth

[*Words and figures enclosed in brackets erased in copy.]

of the diameter of its base, a cap of non-vibratile material rigidly secured to the apex of said conical portion of said tympanum, and a mechanical transmission through which the vibrations produced by the record are transmitted to the tympanum, the tympanum being of sufficient area to impart to the surrounding free air, when the tympanum is so vibrated, sound waves substantially corresponding in intensity to the recorded sound waves; substantially as described.

12. [16.]* In a machine for directly regenerating sound from a record of the same ∧, a ponderous [C¹]* tympanum support having a circular aperture exceeding nine inches in diameter, a light vibratile tympanum mounted rigidly in said aperture, and having its outer edge ∧ secured to said support, said tympanum being shaped to provide an annular rim adjacent said support, and a conical portion [fol. 144] springing from the inner edge of said annular rim, the diameter of the base of said conical portion being not less than eight-tenths of the diameter of said

G^x "

circular aperture in said support, and the altitude of said conical portion being substantially one quarter of the diammeter of its base, a cap of non-vibratile material rigidly secured to the apex of said conical portion of said tympanum, and a mechanical transmission through which the vibrations produced by the record are transmitted to the tympanum, whereby the tympanum imparts to the surrounding free air sound waves substantially corresponding in intensity to the recorded sound waves; substantially as described.

[Cl. 13 follows—see fol. 11778]

Change the numbers of allowed claims 20, 21, 22, 23, 24 and 25 to 17, 18, 19, 20, 21 and 22 respectively.

Cancel claims 26 and 27. Change the number of claim 28 to 23, and in line 5 change "angle" to —angled—.

[*Words and figures enclosed in brackets erased in copy.]

Change the numbers of allowed claims 29, 30, 31, 32 and 33 to 24, 25, 26, 27 and 28.

Cancel claims 34, 35, 36, 37 and 38. Change the numbers of claims 39, 40 and 41 to 29, 30 and 31. Cancel claims 42, 43, 44 and 45. Change the number of allowed claim 46 to [fol. 145] 32. Cancel claims 47 to 53 inclusive. Change the number of allowed claim 54 to 33.

Cancel claims 55 to 62 inclusive. Change the number of allowed claim 63 to 34. Cancel the remaining claims and substitute:

28. [31—35.]* In a sound regenerating machine, a
B[a]. tensioned vibration transmission, a style-holder upon one of said transmission and an untensioned tympanum connected with the opposite end of said transmission, the tension of the transmission being in the direction of its vibration; substantially as described.

Insert F4

[Cls. 29 to 31]

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11813

Remarks

The specification has been amended, and many of the claims have been cancelled, without prejudice, to reduce the number of claims, in deference to the Examiner's suggestion. Other claims have been redrawn to express more clearly the essential novelty of applicant's invention.

New claims 1 and 2 will, perhaps, bear upon their faces the distinguishments relied upon, but they will hereinafter be discussed in connection with the redrawn claims numbered 11 to 16.

Reconsideration of claims now numbered 3 to 8, inclusive, is respectfully requested.

Claim 3 is rejected on Shanks and Amet, No. 562, 753 and No. 562,694; Rep. No. 1,003,655, and Lumiere, in view of [fol. 146] Skiff, Shields and Weeton. We do not find in any one of these patents a cabinet having two compartments, one of which contains a record tablet and the other a tym-

[*Words and figures enclosed in brackets erased in copy.]

panum with a transmission arm extending from one compartment to the other. We are at a loss to understand why the Examiner says there is no invention in this arrangement. As pointed out, the cabinet, having a partition between the record tablet and the tympanum, effects a variety of functions, which are enumerated in the argument filed December 24, 1913. In the absence of such a construction in the prior art, we respectfully submit that the claims should be allowed.

Claim 4 contains the limitation that the transmission arm swings on one side of the partition and the tympanum is mounted upon the transmission arm and swings upon the other side of the partition. We do not understand how the patent to Johnson has any bearing upon this claim. Where

is the partition upon which the transmission arm is supported and through which it extends? In the German patent the tympanum, which is in the small reproducer, is immediately above the record tablet, and we do not see any partition through which the transmission arm extends, or, indeed, any transmission arm at all.

With respect to claim 5, we do not see that Persichetti shows any partition at all, much less a transmission arm extending downwardly through such a partition and carry- [fol. 147] ing a tympanum there beneath, and the same remark applies to Szek British patent.

With respect to claims 6 and 7, we ask for further application of the references or an allowance. We do not understand what relation the flaring of the mouth of the horn in Persichetti would have to these claims, which call for a particular cabinet structure and arrangement, including a transmission arm swinging over the record support and a tympanum carried by the arm and extending under the record support. So far as we can see the references cited against this group of claims have no relation to the invention herein disclosed. The differences are so great that there can be no objection to defining them but it seems to us that they are defined in the claims as now presented.

Claim 8 falls with the group just discussed, and the Examiner is asked to specifically apply the Johnson reference.

We respectfully solicit a careful consideration of the new claims 11 to 16 inclusive, which have been redrawn, following somewhat the form of new claims 1 and 2, to define a tympanum of such area as to produce directly regenerated sound waves substantially corresponding in intensity or amplitude to the recorded sound waves. That is to say, a

tympanum adapted to regenerate by its own movements when vibrated by the record, the original sounds, without [fol. 148] the interposition of any horn or other confining transformer. The Examiner will recognize, we believe, that such a tympanum has long been sought for by those most skilled in the art, and this is evidenced by the patents cited, such as Shanks, Amet and Lumiere. Those patented devices were certainly failures, and, so far as we are aware, no one before the present applicant succeeded in producing such a tympanum. That the applicant has fully succeeded we can prove by the Examiner by demonstration, if he so desires. It is suggested that size is not a patentable limitation, and that in any case Lumiere disclosed a diaphragm more than nine inches in diameter. The fact is that the problem which the applicant endeavored to solve does not exist until the tympanum is made of very large diameter, that is, of diameter large enough to regenerate the original sounds. When work is attempted on such a large diameter it is found that the diaphragm vibrates at different rates and different intensities in different parts, so that it is divided into nodes of great activity, alternating with portions of little or no activity. Lumiere encountered this difficulty and attempted to solve the problem by the structure disclosed in his patent No. 986,477. We believe it can easily be proved that that attempt was a failure. The Lumiere patent belongs to the Victor Talking Machine Company, but that Company has never put upon the market any machines embodying the invention. However that may be, the applicant's claims are carefully distinguished from Lumiere, which is not cited directly as a reference against [fol. 149] them. In our opinion the suggestion that there is

no invention in the form of regenerating tympanum devised by the applicant, is entirely refuted by the Lumiere patent. If the small reproducer diaphragms of conical shape were in themselves sufficient to show those skilled in the art that the difficulties encountered by Lumiere could be overcome by adopting the form adopted by the applicant, then Lumiere would have adopted that form. The fact is that the applicant has succeeded where others, and those most skilled in the art, have failed, and under those circumstances deductions which might otherwise be drawn from the earlier different, but now suggestive, patented structures, are overcome by the historical fact. We do not believe that the Examiner is justified in rejecting the applicant's tympanum claims unless he can find in the prior art a structure which in itself corresponds to those claims.

With respect to old claims 29, 40 and 41, now numbered 29, 30 and 31, we ask the Examiner to take into consideration the foregoing remarks. We believe that it will now be apparent to the Examiner that the selection of the particular dimensions is of the essence of the invention and attains novel results arising from the particular dimensions and such as could not be obtained by the devices shown in the references. If the Examiner desires to hear the results, we can arrange to make a demonstration for him here in New York, paying his traveling expenses for that purpose, or perhaps we can arrange to have one of the [fol. 150] machines taken to the Patent Office.

An early and favorable reconsideration is respectfully solicited.

Pennie, Davis & Goldsborough, Attorneys for Applicant.

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Div. 23—Room 379

Paper No. 6

Address only "The Commissioner of Patents, Washington, D. C.," and not any official by name.

All communications respecting this application should give the serial number, date of filing, title of invention, and name of the applicant.

LCE-Su.

Department of the Interior, United States Patent Office, Washington

February 23, 1915, U. S. Patent Office.
Feb. 23, 1915, Mailed.

Pennie, Davis and Goldsborough, 35 Nassau Street, New York, N. Y.:

Please find below a communication from the Examiner in charge of the application of Marcus C. Hopkins, for Sound Regenerating Machine, filed July 14, 1913, Serial No. 778,-826.

Thomas Ewing, Commissioner of Patents.

[fol. 151] In response to amendment of Feb. 6, 1915.

Page 7, line 7, "which are" should be canceled as duplicated in the following amendment.

It is doubtful to the examiner if a structure as disclosed by applicant will by itself produce sound waves corresponding in intensity to the recorded sound waves, as such requires that the entire energy represented by the recorded waves be transmitted without loss of energy to the diaphragm and that the diaphragm offer substantially no resistance to the movement so transmitted. If applicant insists on claims embodying such a limitation, he should satisfy this office by competent affidavits or by demonstration that such is true.

Claim 1 is rejected on Lumiere, of record, in view of the conical diaphragms of record. As such conical diaphragms are designed to be transversely rigid and operate in producing sound analogously to a piston, there would seem to be no apparent limit within a moderate range on the diameter which could be employed. Therefore, to increase the diameter of any such diaphragm, as in the reference cited, to perform an old function where there is no apparent limit to the diameter than may be employed, is not seen to be a display of invention.

In re Pein, 201 O. G., 570.

Claim 2 is rejected on the above references and reasons.

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778,826—2

No invention is seen, further, in enclosing Lumiere, or a similar structure, in a cabinet, especially in view of Miller, [fol. 152] of record, Fig. 6, or such structures as in

Eckhardt, 903,364, Nov. 10, 1908, (181-3), or

Zappert, English, 17,827, July 31, 1909, (181-3), 1 sheet.

Claim 3 is rejected on the references and for the reasons of record. It is not seen that applicant's partition effects any different function from the partition in any cabinet that separates the record and needle compartment from the sound emitting compartment, as in

English, 947,227, Jan. 25, 1910, (181-3),

or from the partitions in Shields or Welton, of record. Therefore, to mount any of the long arm transmission devices of record in a cabinet with such a separating wall is thought but a matter of wise selection and adaption, and not of invention.

Claim 4 is rejected on the references and for the reasons of record. In Johnson, 12 is a tympanum and 4 a transmitting arm. There would seem to be no invention in mounting Johnson in a cabinet, as in the German structure cited. So, also, e in Welton is a tympanum.

Claim 5 is rejected on the references and for the reasons of record. In Persichetti, a, f, is clearly a partition, and if his transmitting arm h were provided with a diaphragm at the mouth, as in Szek, or with a diaphragm, as in Johnson or Welton, the structure would meet the terms of this claim.

Claims 6 and 7 are rejected on the references and reasons of record and above given. If the mouth of h were flared, as in Szek, it would underlie e. See Fig. 2. The [fol. 153] claims fail to bring out applicant's invention, being so broad and indefinite as to be met in widely different structures not involving invention.

Claim 8 is rejected on Johnson, for the reasons of record.

Claims 9 and 10 are allowed.

Claims 11, 13, 14, 15 and 16 are rejected on the grounds of rejection of claim 1. The interposition of the cap of

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778,826—3

non-vibratile material in Lumiere, or any other type of diaphragm substituted in Lumiere, is not seen to involve invention, in view of the common use of such in the art, for the same purpose as it is employed by applicant.

Claim 12 is rejected on the grounds of rejection of claim 1.

Claims 17 to 28 inclusive are allowed.

Claims 29, 30 and 31 are rejected on Lumiere, in view of the conical diaphragms of record, for the reasons above given.

Claims 32 to 35, inclusive, are allowed.

Claim 7, line 3, "support" should be—holder—.

L. H. S.

W. D. Groesbeck, Exr.
778826—70

[fol. 154] Application Room, Feb. 23, 1916, 1, U. S. Patent Office

Div. 23—Room 379

#7

C

United States Patent Office

Application of Marcus C. Hopkins. Serial No. 778,826. Filed July 14, 1913. Sound Regenerating Machine

New York, February 22, 1916.

The Honorable Commissioner of Patents, Washington, D. C.

SIR: In response to Office Action of February 23, 1915, please amend as follows:

In the specification, page 7 line 16, change "substantially to —at least—, and in line 19 change "substantially" to —at least—.

Page 8, line 20, strike out "that" at the beginning of the line.

Page 7, line 7, cancel "which are."

In the second line of claim 1 and the second line of claim 2, after the word "same" insert/—without an amplifying horn or chamber—/ and [fol. 155] make the same insertion in the second line of claim 11, claim 12, claim 13, claim 14, claim 15 and claim 16.

Per G[x]. C[1].

In claim 7, change "support" to —holder— in line 3.

Remarks

In the last Office Action the Examiner expressed doubt whether the structure disclosed by applicant will itself produce sound waves corresponding in intensity to the recorded sound waves "as such requires that the entire

energy represented by the recorded waves be transmitted without loss of energy to the diaphragm and that the diaphragm offers substantial non-resistance to the movement to be transmitted" and called for affidavits or a demonstration. A demonstration of the machine was made to the Principal Examiner and his assistant last week, and we believe they were satisfied that the machine would produce, without an amplifying horn or chamber, sound waves substantially corresponding in intensity to the original recorded sound waves. Of course, the Assistant Examiner who wrote the last Office Action was mistaken in supposing that there is any necessary relation between the energy represented by the recorded waves and the energy delivered to the air by the diaphragm. Only a minute part of the energy of the recorded waves is gathered in by the recording trumpet and made use of to actuate the recording device. The energy put upon the air by the vibrating [fol. 156] diaphragm is not at all the same energy that existed in the recorded waves, but is the energy of the motor which drives the record tablet in the reproducing machine.

We have amended claims 1 and 2 and claims 11 to 16,

inclusive, to emphasize the fact that the machine has no horn or amplifying chamber. We do not believe that the Examiner will suggest that this is a negative limitation, and its purpose is consistent with the purpose which we have continually followed, that is, to distinguish the present machine from the ordinary machine in which the regenerator comprises a reproducer and a trumpet. In the opening part of the specification, we tried to make it clear that in ordinary machines, the reproducer, or sound box,

is incapable of generating sound waves of such a character as will persist in the air to any substantial extent. The character of the sound made by an ordinary phonograph sound box disconnected from the amplifying horn or chamber, is well known to the Examiner, and is, of course, easily distinguished in his mind from the sound produced by the sound box acting together with the amplifying horn or chamber. It has been demonstrated to the Examiner that the applicant's machine, without any amplifying horn or chamber, will produce a volume of sound which corresponds to the sound produced by the conjoint action of the sound box and amplifying chamber in an ordinary phonograph. In other words, the applicant's machine does, with its large dia- [fol. 157] phragm, what the old machines do with the combined diaphragm and amplifying horn or chamber, and in so doing the applicant's machine overcomes the limitations which necessarily reside in the use of a horn or chamber. This accomplishment is a perfectly definite thing which anyone can understand, which has often been tried before, and which is done by the applicant for the first time. We have done everything we possibly could do to define this distinction in the claims, and it seems to us that they do define it. The additional words inserted in the claims have not been inserted with the intent or purpose of changing their scope, nor is it intended that they shall in any way result in prolonging the prosecution of the case. They are merely an earnest of our purpose to distinguish definitely from the old machines in which an amplifying horn or chamber is used.

We hardly know what we can say in regard to that paragraph of the Examiner's letter which suggests that the

applicant's accomplishment does not involve invention. As we understand it, the argument is that Lumiere proposed

to use a large diaphragm, but not a conical diaphragm; that small conical diaphragms are old in sound boxes, and that consequently there is no invention in using a large conical diaphragm. It seems to us that this proposition need only be stated to refute itself. The fact is that, although small conical diaphragms were old in sound boxes, Lumiere, who is one of the most skilled men in the art, not only did not know that a large conical diaphragm would accomplish his purpose, but was unable to accomplish that [fol. 158] purpose at all. The Lumiere patent is owned by the Victor Talking Machine Company and it is well known to those skilled in the art that the suggestions of Lumiere were abortive and never resulted in an operative machine. The applicant's claims clearly differentiate from the Lumiere patent and that is all that is necessary. On the question of invention the Lumiere patent is pertinent to the present discussion only because it shows that prior to the applicant, the art did not know how to accomplish the applicant's result.

This ground of rejection was applied by the Assistant Examiner to claims 1, 2, 11 to 16 inclusive and 29, 30 and 31, and we do not believe that the present Examiner will insist upon it with respect to any one of those claims.

With respect to claim 2, the suggestion is that there is no invention in enclosing Lumiere by a cabinet of the character specified in claim 2, in view of Miller, Eckhardt or Zappert. In the first place, claim 2 distinguishes from Lumiere so enclosed, and in the second place the other references do not show a phonograph in which the sound producing means could be enclosed in an open-work cabinet, affording substantial free access of the surrounding

air thereto. These other references show horn machines, the very essence of which is that they should be open only on one side. Claim 2 defines an arrangement in which a direct reproducer is surrounded by an open-work cabinet so

that the sound may be given off in every direction. There [fol. 159] is nothing of the sort in the prior art.

With respect to claims 3 to 8, inclusive, the grounds of rejection are not well understood. Many patents have been cited against these claims and the Examiner has applied them in different ways in successive actions. It will, perhaps, be best to discuss each of the claims separately, referring to all of the references cited against them.

Claim 3, which was originally claim 5, was, in the first Office Action, rejected on Shanks, two Emet patents, Repp or Lumiere, mounted in any conventional cabinet as Skiff, "no invention being found in separating the record and diaphragm spaces by a partition," especially in view of Shields or Welton. As we understand it, the Shanks, Emet, Repp and Lumiere patents were cited to show devices in which the sound was reproduced without the use of an amplifier, by a sounding device connected to the needle holder by a transmission arm. It is not suggested that any one of these patents disclosed the combination of claim 3, wherein the record table is located in one compartment, and the sounding device in another, the transmission arm extending through the partition. In Skiff, the record table and the regenerator, comprising a sound box and an amplifying horn, are enclosed in a single compartment, which is pre-

cisely what the applicant does not do. His idea is to have the record table in one compartment which may easily be opened to remove and replace the record, to have the [fol. 160] sounding device in another compartment which is permanently closed, and to so arrange the transmitting arm that it can swing over the record and yet extend through the partition from the record table to the sounding device. In Shields the record holder and sound box are enclosed in the same compartment. There is no transmission arm proper, unless it be considered that the stylus 14 is a transmission arm, in which case it results that the record holder, the transmission arm and the sound box, are all in the same casing. There is no amplifier, because the phonograph illustrated is one of that type which was provided with a branched tube, the terminals of which were to be

placed in the ears of the listener. In Welton the record table, transmission arm and sound box are in one compartment, through the wall of which the tone arm extends, an amplifying horn being attached to the tone arm outside of the casing. There is here no cabinet with two compartments, and we are unable to imagine in what respect the Examiner supposed that it has any bearing on claim 3.

In the second Office Action this claim was rejected on the references of record without any application of those references. In the last Office Action the claim was rejected on the references of record, together with the patent to English No. 947,227, which shows the ordinary Victrola type of machine with encased horn. It is true that in this machine, as in all machines of the Victrola type, there are

two compartments, one containing the record disk, the [fol. 161] transmission arm and the sound box, together with the tone arm, and the other containing the amplifying chamber. It seems to us that claim 3 definitely distinguishes from such an arrangement, in that it specifies a transmission arm extending from one compartment to another with a tympanum located in one compartment and connected with the transmission arm. It would be a great mistake for the Examiner to assume that it was an easy thing to devise and construct a transmission arm capable of carrying the vibrations from the record groove to the outer edge of the record and through a partition to the tympanum. That was a very difficult thing to do, and in our judgment warrants the allowance of claim 3.

Claim 4 was originally claim 6, and was allowed in the first Office Action. In the second Office Action it was rejected on Johnson No. 1,015,321, together with Shields or Welton or the German patent No. 220,412. The Johnson patent shows merely a usual type of tone arm and the mechanism of the phonograph, excepting the motor, is entirely unenclosed. The Shield and Welton patents have already been considered. The German patent is practically the same as Welton, excepting that the record table is covered by movable cover d. We do not understand how this is to be applied to the claim. In the last Office Action the Examiner says, referring to the Johnson patent, that "12

is a tympanum and 4 a transmitting arm." That is certainly putting an extraordinary construction upon the [fol. 162] language of claim 4, but let us apply that interpretation. If 4 is the transmission arm, then what is the partition upon which it is supported and through which it extends, and how can the tympanum 4 swing?

The Examiner apparently recognized that the Johnson reference is lacking in the cabinet structure claimed, and says that there would be no invention in mounting Johnson in the cabinet of the German patent. We do not understand how this mounting is to be made so that the claim will read upon it, but even if that can be done, it would be to reject the claim on references which lack the very thing claimed. The Examiner also suggests that in Welton e is the tympanum, but in this case he is no better off than in the Johnson patent. There is no partition upon which the transmission arm is mounted and through which it extends.

Claim 5, which was originally claim 7, was allowed in the first Office Action. In the second Office Action it was rejected on the combination of the French patent No. 397,609 and the British patent No. 8011 of 1906. In the French patent the tympanum is the ordinary sound box diaphragm and there is a horn which extends downwardly through a bracket arm f which cannot by any stretch of the imagination be considered a partition. Even if it were a partition, the claim would not be met. It is not pretended that the British patent meets the claim, and by combining the two the Examiner has added the very thing which characterizes the claim. Furthermore, the combination suggested by the [fol. 163] Examiner would still not have any transmission arm extending through a partition.

Claim 6 originally claim 8, was allowed in the first Action and rejected in the second on the same references as claim 5, originally claim 7, and the same remarks apply to this claim. We may point out that it is one thing to bend a horn or tone arm, and another thing to produce a transmission arm which will change the direction of the vibra-

tions, as is necessary in claims 5 and 6. Really, the only difference between the action on claim 5 and the action on claim 6, is that claim 6 includes the further limitation that the tympanum is beneath the support and since this is not found in either of the references, the Examiner proposes to modify them so as to include it. Why should he not, having already injected into the references the characteristic element of the claim, which they did not disclose? Claim 7, originally claim 9, is rejected on the same references, and nothing need be said about it. Claim 8, originally claim 11, was rejected in the first action on Shelbe No. 957,994, and has been amended. In the second Office Action, as claim 10, it was rejected on Johnson, and in the last Office Action this rejection was repeated. To sustain this rejection the Examiner says "4 and 7 are two arms," whereas the fact is that 4 and 7 are one arm; but even considering them as two arms, the tympanum is not carried by the arm 7.

[fol. 164.] It seems to us that the real explanation of the somewhat extraordinary application of references just discussed is found in the last Office Action, where the Examiner says:

'The claims fail to bring out applicant's invention, being so broad and indefinite as to be met in wisely different structures not involving invention."

We have carefully considered this suggestion, and it seems to us that the claims are not open to that criticism. If they are, we would be glad to amend them, but after re-reading the specification, we think these claims properly define the intended structure and could not be misunderstood. If the

Examiner thinks otherwise, we would be glad to know it and have him say specifically wherein the claims are indefinite.

Although we understand that the Assistant Examiner who will act upon the case in response to this amendment is not the Assistant Examiner who has heretofore acted

upon the case, yet we would like, if possible, to get a final action at this time.

Respectfully submitted.

Pennie, Davis & Goldsborough, Attorneys for Applicant.

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[fol. 165] 2—260

Room 379, Div. 23

Paper No. 8

Address only "The Commissioner of Patents, Washington, D. C.," and not any official by name.

All communications respecting this application should give the serial number, date of filing, title of invention, and name of the applicant.

FE.

Department of the Interior, United States Patent Office, Washington

March 4, 1916, U. S. Patent Office.
Mar. 4, 1916, Mailed.

Pennie, Davis and Goldsborough, 35 Nassau Street, New York, N. Y.:

Please find below a communication from the Examiner in charge of the application of Marcus C. Hopkins, for Sound Regenerating Machine, filed July 14, 1913, Serial No. 778,826.

Thomas Ewing, Commissioner of Patents.

In response to amendment of Feb. 23, 1916.

Claims 1, 3, 11 to 16 and 29 to 31 are rejected as indefinite. The specification of the size according to results is believed to be too indefinite. The examiner understands that the base diameter and the altitude must have a definite relative proportion, and that the base diameter must be substantially nine inches in order that satisfactory results can be obtained. To merely specify this size by the result is be- [fol. 166] lieved to be too indefinite. The basis of reference

which is stated to be the recorded sound waves is believed to be an indefinite reference base, and that such a range would be too great and variable to be readily determined. For instance, a limitation such as from eight to ten inches for the base diameter might be given. The statement in some of the claims that the diameter exceeds nine inches is not believed to be sufficiently definite. If it is immaterial what the size is within a considerable range, then it is a mere question of expediency, or selection of any size one desires for any loudness, and would not involve invention.

Claims 3 to 6 are rejected on the references and reasons of record. It is not believed to require invention to put a

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partition anywhere one desires. If there is any invention, it is in the adaptation of the partition to the particular device. In other words, the construction by which the partition can be used is what involves the invention, if any, and not merely the idea of using a partition, as the claims now state. Attention is called to the decision in Thatcher Heating Co. vs. Burtis et al., C. D. 1887, 320 (or 39 O. G., 587), in which the U. S. Supreme Court held that there was no invention in the combination involved, no matter how or by what means it was effected; that the invention was in the means employed in making the adaptation.

[fol. 167] The case appears otherwise allowable, as now advised.

W. D. Groesbeck, Exr.

F.

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Application Room, Mar. 28, 1916, U. S. Patent Office

Room 379

#9

United States Patent Office

Marcus C. Hopkins. Filed July 14, 1913. Serial No. 778,826. Sound Regenerating Machines

Hon. Commissioner of Patents.

SIR: In response to the Official action of March 4, 1916, please amend as follows:

Page 6, last line, after "gripped between" insert — and rigidly supported —.

Claims 1 and 2, line 3, after "panum" insert — of
D¹ large area rigidly supported at its periphery and freely exposed to unconfined air —.

Claims 11 and 12, line 3, after "tympanum" insert — of large area —.

D² Claim 11, line 4, before "mounted" insert — rigidly —.

[fol. 168] Claim 12, line 4, before "mounted" insert — having its outer edge rigidly —.

Claim 13, line 5, before "mounted" insert — rigidly —.

Claim 14, line 3, after "aperture" insert — exceeding nine inches in diameter —. Line 4, before "secured" insert — rigidly —.

Claim 15, line 3, after "tympanum" insert — of large area —. Line 4, before "secured" insert —
per G¹ rigidly —. Line 6, after "support," insert —/
D³ [the inner diameter of said rim exceeding nine]* inches, —.

Claim 16, line 5, before "secured" insert — rigidly —.

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[*Words and figures enclosed in brackets erased in copy.]

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Claims 29, 30 and 31, line 1, after "tympanum" in-
D' sert —/[rigidly supported at its periphery]*—./

The foregoing amendments are made as the result of an oral interview recently had with the Examiner, at which it was agreed that the said amendments would not only more clearly define the invention, but would also render the material distinctions between the same and the prior art, including a number of patents which show horns or amplifiers of paper or other similar material directly associated with the reproducer needle, clearly apparent. It is essential to the success of applicant's machine that the tympanum be of large area and that the base of the vibra- [fol. 169] tile portion thereof exceed nine inches in diameter, and furthermore that the peripheral edge of the tympanum, exterior of the vibratile portion, be rigidly secured or tightly gripped between the rings of the supporting frame. These definitions of the essential characteristics of the invention have been included in the claims by the amendments aforesaid, and said claims are, therefore, believed to be allowable.

The Examiner's objection that applicant indicates only the lower limit of the diameter of the tympanum and does not include both limits, is believed to be without substantial foundation. Applicant has demonstrated that his invention is not wholly satisfactory when the conical tympanum is made with a basal diameter of less than nine inches. He has also found that tympanums of much larger diameter are eminently successful, but he is not prepared to even indicate any maximum limit in respect of such diameter, nor should a statement of such an upper limit be required. He has produced a highly successful device which is novel and useful, and as the prior art discloses no similar device either structurally or operatively considered, it is submitted

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that he has properly defined his invention in the claims, when he has distinguished the device, as so defined in the claims, from the prior art.

For example, in claims 1 and 2, it is stated that the vibratile conical tympanum is of large area rigidly supported at

[*Words and figures enclosed in brackets erased in copy.]

[fol. 170] its periphery and freely exposed to unconfined air, so that when the tympanum is vibrated, it imparts to the surrounding free air, sound waves corresponding in intensity to the recorded sound waves. At a recent demonstration before the Examiner and his assistants, at the offices of applicant's attorneys in this city, it was made clearly manifest that the machine embodying the present invention did reproduce sounds or sound waves substantially corresponding in intensity to the recorded sound waves. The demonstrating machine was without any amplifying devices whatever in the form of a horn or sound-box, and the Examiner will recall that the sounds reproduced were clear, resonant, self-sustained and of admirable quality and timbre, and of an intensity which obviously approximated that of the recorded sound waves. It is, therefore, believed that the expression "substantially corresponding in intensity with the recorded sound waves" is correct and perspicuous and can give rise to no uncertainty or ambiguity. Of course, the term substantially implies a certain latitude, which the facts in the case would appear to justify, as all of the reproductions of recorded sounds by applicant's machine clearly indicate to the ordinary ear that they necessarily approximate the recorded sounds not only in intensity, but in timbre and quality.

In the other claims, as amended, the characteristic feature of mounting or supporting the outer edge of the vibratile tympanum rigidly on a support is brought out, and in [fol. 171] some of the claims, the lower limit of the diameter of the vibratile portion of the tympanum is set forth, and as all of these amendments go to structure and differentiate such structure from the prior art, it is urged that the claims are no longer open to the objection of indefiniteness.

In respect of the prior art patents, not of record, but to which attention has been called, and which show horns or other amplifying devices made of paper or the like and directly associated with the needle or stylus, attention is called to the fact that these devices do not differ in character from the ordinary amplifying horn or sound-box, and

are not per se vibratile tumpanæ, but mere amplifiers or condensers of sound waves. Furthermore, none of these prior art devices show any equivalent of a tympanum having its outer edge rigidly mounted in a support. In short, the horn-like reproducers are nothing more than the ordinary horn or amplifying megaphone having the stylus directly attached to its wall, so that the stylus sets up a localized vibration, which is confined within the flaring body of the horn and amplified and reproduced as sound waves, not by any vibration of the horn as a whole, but merely by the condensation and amplification of the vibrations of the stylus and the portion of the material of the horn immediately adjacent the stylus connection.

[fol. 172] It is respectfully submitted that as amended, the claims clearly define the essential novelty of applicant's invention and should be allowed.

Respectfully submitted.

Marcus C. Hopkins, by Pennie, Davis & Goldsborough, Attorneys.

4 778826—86

2—260

Div. 23, Room 379

Paper No. 10

Address only "The Commissioner of Patents, Washington, D. C.," and not any official by name.

All communications respecting this application should give the serial number, date of filing, title of invention, and name of the applicant.

FE.

Department of the Interior, United States Patent Office, Washington

Apr. 1, 1916, U. S. Patent Office. Apr. 1, 1916, Mailed.

Pennie, Davis and Goldsborough, 35 Nassau Street, New York, N. Y.:

Please find below a communication from the Examiner in charge of the application of Marcus C. Hopkins, for Sound

Regenerating Machine, filed July 14, 1913, Serial No. 778,826.

Thomas Ewing, Commissioner of Patents.

[fol. 173] In response to amendment of March 28, 1916.

No reply was made to the rejection of claims 3 to 6, made in the last office action. It is thought that this was an oversight by applicant.

The amendment above mentioned must therefore be held to be an incomplete response to the last office action.

W. D. Groesbeck, Exr.

F. 778826—87

United States Patent Office

Room 379

#11

E

M. C. Hopkins. Filed July 14, 1913. Serial No. 778,826.
Sound Regenerating Machine

Hon. Commisioner of Patents.

SIR: In the matter of the above entitled application, please cancel claims 3 to 6 inclusive and re-arrange the numerals of the other claims accordingly.

It was intended to cancel these claims by the last amendment, but through an inadvertence the matter was overlooked. The case is now believed to be in condition for allowance, and it is respectfully requested that it be passed to issue.

Respectfully submitted.

M. C. Hopkins, by Pennie, Davis & Goldsborough, Attorneys.

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[fol. 174] 2—181

BU. Serial No. 778,826

Address only the Commissioner of Patents, Washington, D. C.

Department of the Interior, United States Patent Office, Washington

April 11th, 1916.

Marcus C. Hopkins, Assor.

SIR: Your application for a patent for an improvement in Sound Regenerating Machine, filed July 14th, 1913, has been examined and allowed.

The final fee, twenty dollars, must be paid not later than six months from the date of this present notice of allowance. If the final fee be not paid within that period, the patent on this application will be withheld, unless renewed with an additional fee of $15, under the provisions of Section 4897, Revised Statutes.

The office delivers patents upon the day of their date, and on which their term begins to run. The printing, photolithographing, and engrossing of the several patent parts, preparatory to final signing and sealing, will require about four weeks, and such work will not be undertaken until after payment of the necessary fee.

When you send the final fee you will also send, distinctly and plainly written, the name of the inventor, title of inven-[fol. 175] tion, and serial number as above given, date of allowance (which is the date of this circular), date of filing, and, if assigned, the names of the assignees.

If you desire to have the patent issue to assignees, an assignment containing a request to that effect, together with the fee for recording the same, must be filed in this office on or before the date of payment of final fee.

After issue of the patent uncertified copies of the drawings and specifications may be purchased at the price of five cents each. The money should accompany the order. Postage stamps will not be received.

Final fees will not be received from other than the applicant, his assignee or attorney, or a party in interest as shown by the records of the Patent Office.

Respectfully, Thomas Ewing, Commissioner of Patents.

Pennie, Davis & Goldsborough, 35 Nassau St., New York, N. Y.

[On left margin:] In remitting the final fee give the serial number at the head of this notice.

[On right margin:] Uncertified Checks will not be Accepted.

778826—89

[fol. 176] 122. 2036. 23

$15 Rec'd. Mar. 22, 1918. C. C. U. S. Pat. Office.

#12

Petition

Honorable Commissioner of Patents, Washington, D. C.

SIR: Your petitioner, Marcus C. Hopkins, a citizen of the United States, residing in the Borough of Manhattan, City, County and State of New York, whose post office address is No. 35 Nassau Street, New York City, N. Y. represents that on July 14, 1913, he filed an application for Letters Patent for an improvement in sound regenerating machines, Serial Number 778,826, which application was allowed April 11, 1916, but that he failed to make payment of the final fee within the time allowed by law. He now makes renewed application for Letters Patent for said invention, and prays that the original specification, oath and drawings, may be used as a part of this application.

Signed at New York City, New York, on this 21st day of March, 1918.

Marcus C. Hopkins, by Pennie, Davis & Goldsborough, His Attorneys.

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[fol. 177] 2036 11821

#13

F

Div. 23, Room 379

United States Patent Office

Application of Marcus C. Hopkins. Renewal Serial Number 224,048. Filed March 22, 1918. Sound Regenerating Machine

New York, March 28, 1918.

Honorable Commissioner of Patents, Washington, D. C.

SIR: Prior to the examination on the merits of the above case, please enter the following amendments as hereby directed:

Page 6, erase from "The," line 13, through which," line 14, and substitute:/—Two of the three arms of the said spider—/; same page, line 24, correct the spelling of "underly" to underlie; change the last line as amended to read:/—[which peripheral portion or supporting rim 1 is tigthly gripped and rigidly supported between the]*—./

F[1]

F[2].

Page 14, between lines 5 and 6, insert the following:

F[3]. It will be noted that the distance between the point of the style q′ and the axis of the lever Q is greater than the length of the arm U which projects from the center of the lever R and to which the rod V is connected. By reason of this fact, and of the fact that the levers Q and R, and [fol. 178] the rod links S, S′ form a parallelogram, the length of vibration of the tympanum is relatively much less than that of the style, and the tympanum thus offers little resistance.

778826—91

11822

to the movement of the style, thereby greatly reducing the wear on the record. To compensate for this small movement

[*Words and figures enclosed in brackets erased in copy.]

of the tympanum, its large area enables it to move a large body of air, so as to obtain sound waves of large volume and great carrying power.—

In line 2 of each of claims 5 and 6, insert a comma after "members."

Cancel claims 25, 26 and 27.

Add the following claims:

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29. In a sound-regenerating machine, a vibratile conical tympanum of large area rigidly supported at its periphery and freely exposed to unconfined air, a sound-vibrated element, and vibration transmission means connecting said element and said tympanum and arranged to impart to the tympanum vibrations which are relatively much shorter than the vibrations imparted to the said element.

F⁴.

30. In a sound-regenerating machine, a vibratile conical tympanum rigidly supported at its periphery and freely exposed to unconfined air, a sound-vibrated element, and vibration transmission means connecting said element and said tympanum arranged to impart to the tympanum vibrations which are relatively much shorter than the vibra-
[fol. 179] tions imparted to the said element; the tympanum having an area sufficiently large to effect, without amplification, sound waves of large volume and carrying power.

31. In a sound-regenerating machine, a vibratile conical tympanum of large area, rigidly supported at its periphery and freely exposed to unconfined air, a sound-vibrated element, and tensioned transmission means connecting said element and said tympanum and arranged to impart to the

tympanum vibrations which are relatively much shorter than the vibrations imparted to the record end of the style.

Remarks

It is desired to acknowledge the courtesy of the several extended interviews recently accorded in the matter of the

above case. The added claims are based on claims standing allowed in the case and are assumed for that reason to be allowable. A short explanation has been incorporated in the specification as regards the relative length of the vibrations of the tympanum and the style or the sound vibrated element.

Claims 25, 26 and 27 have been canceled, as those claims will be incorporated, together with others, in a divisional application directed to the tympanum or diaphragm per se.

Respectfully submitted.

Pennie, Davis & Goldsborough, Attorneys for Hopkins.

3 778826—93

[fol. 180] 2—260

Div. 23, Room 217

Paper No. 14

Address only "The Commissioner of Patents, Washington, D. C.,- and not any official by name.

All communications respecting this application should give the serial number, date of filing, title of invention, and name of the applicant.

WBB.

Department of the Interior, United States Patent Office, Washington

April 5, 1918, Patent Office.
Apr. 5, 1918, Mailed.

Pennie, Davis & Goldsborough, 35 Nassau St., New York.

Please find below a communication from the Examiner in charge of the application of Marcus C. Hopkins, Serial No. 224,048, filed March 22, 1918, Sound Regenerating Machine.

James T. Newton, Commissioner of Patents.

Responsive to amendment filed March 22, 1918.

Before this case can be passed to issue it will be necessary for applicant to certify over his own signature that his

address as given in the renewal petition is correct, as it does not correspond with the address given in his original petition.

[fol. 181] When properly certified the case may then be allowed.

W. D. Groesbeck, Examiner.

778826—94

Application Div., Apr. 18, 1918, U. S. Patent Office

#15. GX. Letter attached

In the United States Patent Office

Before the Examiner

Room 217, Div. 23

In re Application of Marcus C. Hopkins. Sound Regenerating Machine. Filed March 22, 1918. Serial No. 224,048.

Hon. Commissioner of Patents, Washington, D. C.

Sir: In response to the Official action of April 5, 1918, entry of the following amendments is hereby directed:

In line 2, of each of present claims 1, 2, 7, 8, 9, 10, 11, 12, erase "without an amplifying horn or chamber."

The matter to be erased is incorporated as an amendment in the communication filed February 23, 1916. Upon consideration, it appears that said matter is unnecessary to [fol. 182] the claims from which it is erased.

Enter the attached signed statement as to applicant's post office address.

Allowance of the case is asked.

Respectfully submitted.

Marcus C. Hopkins, by Pennie, Davis & Goldsborough, Attorneys.

Washington, D. C., April 18, 1918.

778826—95

Apr. 18, 1918, U. S. Patent Office

22. 2036

Div. 23, Room 379

Application Div.

United States Patent Office

Application of Marcus C. Hopkins. Renewal Serial Number 224,048. Filed March 22, 1918. Sound Regenerating Machines

New York, N. Y., April 6, 1918.

Honorable Commissioner of Patents, Washington, D. C.

SIR: I hereby certify that my address as given in the renewal petition in the above-entitled application is correct; [fol. 183] that I now reside in the borough of Manhattan, city, county and State of New York, and that my post office address is No. 35 Nassau Street, New York City.

Respectfully, Marcus C. Hopkins.

778826—96

Application Div., Apr. 20, 1918, U. S. Patent Office

12—3. 2036. 11824

#16

G

Room 217, Div. 23

In the United States Patent Office

Application of Marcus C. Hopkins. Filed March 22, 1918. Serial No. 224,048. Sound Regenerating Machine

New York, N. Y., April 19, 1918.

Honorable Commissioner of Patents, Washington, D. C.

SIR: Claim 11, change line 6, as amended, to read, an

G'. annular rim adjacent said support, the outer diameter of said rim exceeding nine inches, and a conical por-

---

[fol. 184] Remarks

Claim 11 has been amended to correct an inaccuracy which renders it inconsistent with, e. g., Claim 12. The circular aperture in the support exceeds nine inches in diameter.

Respectfully submitted.

Pennie, Davis and Goldsborough, Attorneys for Hopkins.

778826—97

2—181

Address only the Commissioner of Patents, Washington, D. C.

AH. Serial No. 778,826. 224,048

Department of the Interior, United States Patent Office, Washington

May 1, 1918.

Marcus C. Hopkins, Assor.

SIR: Your application for a patent for an improvement in Sound Regenerating Machine, filed Mar. 22, 1918, has been examined and allowed.

The final fee, twenty dollars, must be paid not later than six months from the date of this present notice of allowance. If the final fee be not paid within that period, the patent on this application will be withheld, unless renewed

[On left margin:] In remitting the final fee give the serial number at the head of this notice.

[On right margin:] Uncertified checks will not be accepted.

[fol. 185] with an additional fee of $15, under the provisions of Section 4897, Revised Statutes.

The office delivers patents upon the day of their date, and on which their term begins to run. The printing, photolithographing, and engrossing of the several patent parts, preparatory to final signing and sealing, will require about four weeks, and such work will not be undertaken until after payment of the necessary fee.

When you send the final fee you will also send, distinctly and plainly written, the name of the inventor, title of invention, and serial number as above given, date of allowance

(which is the date of this circular),* date of filing, and, if assigned, the names of the assignees.

If you desire to have the patent issue to assignees, an assignment containing a request to that effect, together with the fee for recording the same, must be filed in this office on or before the date of payment of final fee.

After issue of the patent uncertified copies of the drawings and specifications may be purchased at the price of five cents each. The money should accompany the order. Postage stamps will not be received.

Final fees will not be received from other than the applicant, his assignee or attorney, or a party in interest as [fol. 186] shown by the records of the Patent Office.

Respectfully, J. T. Newton, [Thomas Ewing],* Commissioner of Patents.

Pennie, Davis & Goldsborough, 35 Nassau Street, New York, N. Y.

778826—98

Mail Room, Jun. 3, 1918, U. S. Patent Office

Washington, D. C., June 3, 1918.

Hon. Commissioner of Patents, Washington, D. C.

Sir: Final fees are being paid to-day in the following cases of Marcus C. Hopkins, 778,826, Renewal 224,048, Sound Regenerating Machine; 808,577, Renewal 224,049, Sound Regenerating Machine; and 229,014, Acoustic Device. It is requested that the case first identified be given the lowest patent number.

Very respectfully, Pennie, Davis, Marvin & Edmonds.

778826—99

[fol. 187] 2—327

2036

$20 Rec'd Jun. 3, 1918. C. C., U. S. Pat. Office

Memorandum of Fee Paid at United States Patent Office

(Be careful to give correct Serial No.)

778,826

Serial No. Re. 224,048. June 1, 1918.
Inventor: Marcus C. Hopkins.

[*Words and figures enclosed in brackets erased in copy.]

Patent to be issued to Lektophone Corporation.

Name of invention, as allowed: Sound regenerating machine.

Date of payment: June 3, 1918.

Fee: Twenty dollars.

Date of filing: March 22, 1918.

Date of circular of allowance: May 1, 1918.

The Commissioner of Patents will please apply the accompanying fee as indicated above.

Pennie, Davis & Goldsborough, Attorneys.

[fol. 188] Send patent to Pennie, Davis, Marvin & Edmonds, 35 Nassau Street, New York City.

778826—100

Pennie, Davis, Marvin and Edmonds, Counsellors at Law, 35 Nassau Street

John C. Pennie, William H. Davis, Arba B. Marvin, Dean S. Edmonds, F. E. Barrows, W. B. Morton

Walter J. Gill, Jr., G. J. Hesselman, Merton W. Sage, E. H. Merchant, A. S. McDaniel, W. H. Taylor, Jr., V. T. Houghton, M. T. Fisher, David Weild

Washington Offices: 910 Washington Loan & Trust Bldg., Washington, D. C.

New York Cable Address: Penangold, New York, Western Union Code

Telephone: 1127 Rector

B. 2036

New York, August 24, 1920.

Honorable Commissioner of Patents, Washington, D. C.

Sir: In comparing our office copy of the file-wrapper with the original deed of patent No. 1,271,527 issued on the second day of July, 1918, to Marcus C. Hopkins, for Sound Regenerating Machine, we note the following errors occurring in the printed copy:

Page 1, line 25, "magaphone" appears for —megaphone—;

Page 5, lines 75 and 95; page 6, line 25, "long" appears for —large—.

[fol. 189] We are enclosing the original patent deed herewith and request that you kindly issue a certificate of correction covering these inaccuracies.

Very respectfully, Pennie, Davis, Marvin & Edmonds.

Enclosure.

Approved Sep. 16, 1920. R. F. Whitehead, Commissioner of Patents.

778826—101

Address only the Commissioner of Patents, Washington, D. C.

Letter No. —

Department of the Interior, United States Patent Office, Washington

7 September, 1920.

In the Matter of Letters Patent No. 1,271,527. Marcus C. Hopkins. Sound-regenerating Machines. July 2, 1920. Pennie, Davis, Marvin and Edmonds, Attorneys.

Report of the Acting Chief of the Issue and Gazette Division

The attorneys return the Letters Patent with a request that a certificate of correction be issued correcting the following errors:

1. Page 1, line 25, "magaphone" should be megaphone.

[fol. 190] 2. Page 5, lines 75 and 95, page 6, line 25 the word "long" should be large.

The first error is chargeable to the printer. The second error is caused through the incorrect entry of a portion of amendment "D" paper 9, filed March 28, 1916.

Respectfully John Hans, Acting Chief of Issue and Gazette Division.

To the Commissioner of Patents:

have been checked and are found

The errors referred to [appear]* to have occurred in

[*Words and figures enclosed in brackets erased in copy.]

the manner alleged by the Chief of the Issue and Gazette Division.

Respectfully, W. D. Groesbeck, Exr., Div. 23.

778826—102

October 6, 1920.

Messrs. Pennie, Davis, Marvin & Edmonds, 35 Nassau Street, New York, N. Y.

SIRS: Herewith please find Letters Patent No. 1,271,527, granted July 2, 1918, upon the application of Marcus C. Hopkins, returned to you with a certificate of correction endorsed thereon in accordance with your request.

Respectfully, Wm. I. Wyman, Chief Clerk.

Encl. 778826—103

[fol. 191] Mail Room, Nov. 12, 1924, U. S. Patent Office

#17

UNITED STATES DISTRICT COURT, SOUTHERN DISTRICT OF NEW YORK

Honorable Commissioner of Patents, Washington, D. C.

SIR: In compliance with the Act of February 18, 1922 42
([41]* Stat. L. 392), you are advised that there was filed on the 10th day of November, 1924, in this court an action, suit, or proceeding No. E30-256, entitled Name: Lektophone Corporation, Plaintiff, Address: Jersey City, New Jersey, versus Name: Western Electric Company, Inc., Defendant, Address: New York, N. Y., brought upon the following patents:

	Patent No.	Date of patent	Patentee
1.	1,271,527	July 2nd, 1918	Lektophone Company.
2.			
3.			
4.			
5.			

[*Words and figures enclosed in brackets erased in copy.]

[fol. 192] In the above-entitled case on the — day of ——, 192-, the following patents have been included by — (insert amendment, answer, cross bill, or other pleading):

	Patent No.	Date of patent	Patentee
1.	.....	.....	.....
2.	.....	.....	.....
3.	.....	.....	.....
4.	.....	.....	.....
5.	.....	.....	.....

In the above-entitled case the following decision has been rendered or decree issued:

.....

.....

In witness whereof I have affixed my hand this 11th day of November, 1924, at New York, N. Y.

Alex Gilchrist, Jr., Clerk of said Court.

778826—104

Mail Room, Feb. 18, 1925, U. S. Patent Office

#18

UNITED STATES DISTRICT COURT, SOUTHERN DISTRICT OF NEW YORK

Honorable Commissioner of Patents, Washington, D. C.

SIR: In compliance with the Act of February 18, 1922 42
[fol. 193] ([41]* Stat. L. 392), you are advised that there was filed on the 13th ady of February, 1925, in this court an E31—
action, suit, or proceeding No. [E31]*—171, entitled Name: Lektophone Corporation, Plaintiff, Address: Jersey City, N. J., versus Name: Vitalis Himmer, Jr., Defendant, Address: N. Y., N. Y., brought upon the following patents:

[*Words and figures enclosed in brackets erased in copy.]

	Patent No.	Date of patent	Patentee
1.	1,271,527	July 2, 1918	Marcus C. Hopkins.
2.			
3.			
4.			
5.			

In the above-entitled case, on the — day of ——, 192-, the following patents have been included by — (insert amendment, answer, cross bill, or other pleading):

	Patent No.	Date of patent	Patentee
1.			
2.			
3.			
4.			
5.			

[fol. 194] In the above-entitled case the following decision has been rendered or decree issued:

. . . . . .

. . . . . .

In witness whereof I have affixed my hand this 14th day of February, 1925, at New York, N. Y.

Alex Gilchrist, Jr., Clerk of said Court.

778826—105

Mail Room, May 28, 1925, U. S. Patent Office

#19

UNITED STATES DISTRICT COURT, SOUTHERN DISTRICT OF NEW YORK

Honorable Commissioner of Patents, Washington, D. C.

SIR: In compliance with the Act of February 18, 1922
42
[41]* Stat. L. —), you are advised tha tthere was filed on the 3rd day of March, 1925, in this court an action, suit, or

[*Words and figures enclosed in brackets erased in copy.]

proceeding No. 2075, entitled Name: Lektophone Corp., Plaintiff, Address: Jersey City, N. J., versus Name: Sylo Lighting Fixture Co., Defendant, Address: 166 Flatbush Ave., Brooklyn, New York, brought upon the following patents:

[fol. 195]

	Patent No.	Date of patent	Patentee
1.	1,271,527	July 2, 1918	Plaintiff as Assignee.
2.	1,271,529	July 2, 1918	Plaintiff as Assignee.
3.	.....	.....	.....
4.	.....	.....	.....
5.	.....	.....	.....

In the above-entitled case, on the — day of ——, 192-, the following patents have been included by — (insert amendment, answer, cross bill, or other pleading):

	Patent No.	Date of Patent	Patentee
1.	.....	.....	.....
2.	.....	.....	.....
3.	.....	.....	.....
4.	.....	.....	.....
5.	.....	.....	.....

In the above-entitled case the following decision has been rendered or decree issued:

.....

.....

[Matter enclosed between rules erased in copy.]

In witness whereof I have affixed my hand this 25th day of May, 1925, at Brooklyn, New York.

Percy G. B. Gilken, Clerk of said Court.

[fol. 196] Mail Room, Nov. 3, 1925, U. S. Patent Office

20

UNITED STATES DISTRICT COURT, DISTRICT OF NEW JERSEY

Honorable Commissioner of Patents, Washington, D. C.

SIR: In compliance with the Act of February 18, 1922

42

[41]* Stat. L. —), you are advised that there was filed on the 4th day of September, 1925, in this court an action, suit, or proceeding No. E-1431, entitled Name: Lektophone Corporation, Plaintiff, Address: Jersey City, N. J., versus Name: De Forest Radio Company, Defendant, Address: 139 Franklin St., Jersey City, N. J., brought upon the following patents:

	Patent No.	Date of patent	Patentee
1.	1,271,527	July 14, 1913	Marcus C. Hopkins
2.	1,271,529	July 14, 1913	Marcus C. Hopkins
3.			
4.			
5.			

In the above entitled case, on the — day of ——, 192-, the following patents have been included by — (insert amend-

[fol. 197] ment, answer, cross bill, or other pleading):

	Patent No.	Date of patent	Patentee
1.			
2.			
3.			
4.			
5.			

In the above-entitled case the following decision has been rendered or decree issued:

In witness whereof I have affixed my hand this 28th day of October, 1925, at Trenton, N. J.

George T. Cranmer, Clerk of said Court, R. S. Chevrier, Deputy.

778826—107

(Here follow drawings, side folios 198, 199, 200, 201, and 202)

[*Words and figures enclosed in brackets erased in copy.]

M. C. HOPKINS.

SOUND REGENERATING MACHINE.

APPLICATION FILED JULY 14, 1913. RENEWED MAR. 22, 1918.

1,271,527. Patented July 2, 1918.

3 SHEETS—SHEET 1.

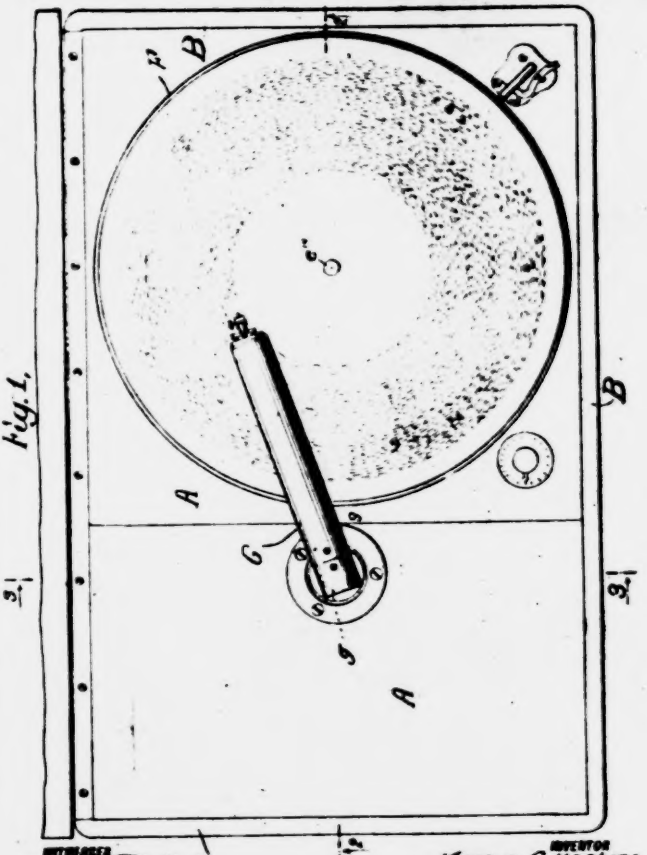


Fig. 1.

WITNESSES
M. A. Bill

INVENTOR
Marcus C. Hopkins

ATTORNEYS

110

M. C. HOPKINS.

SOUND REGENERATING MACHINE.

APPLICATION FILED JULY 14, 1913. RENEWED MAR. 22, 1918.

1,271,587. Patented July 2, 1918.

3 SHEETS—SHEET 2

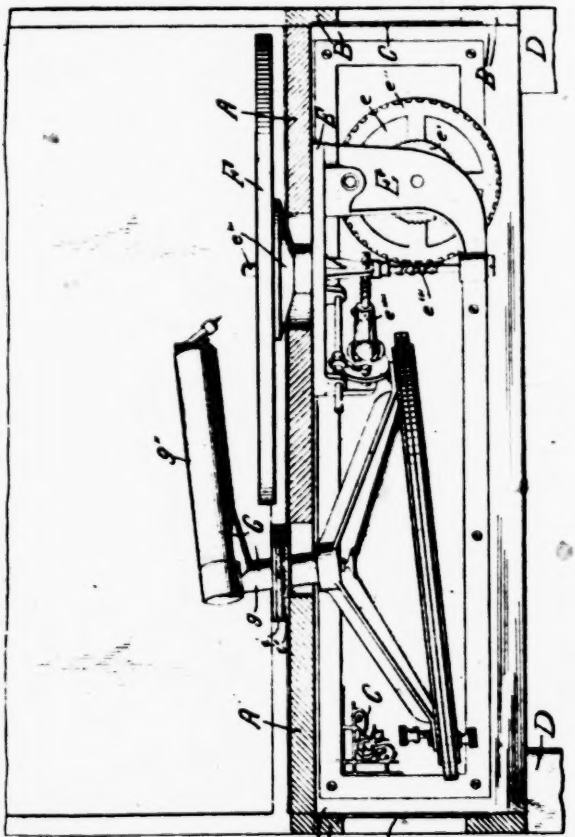


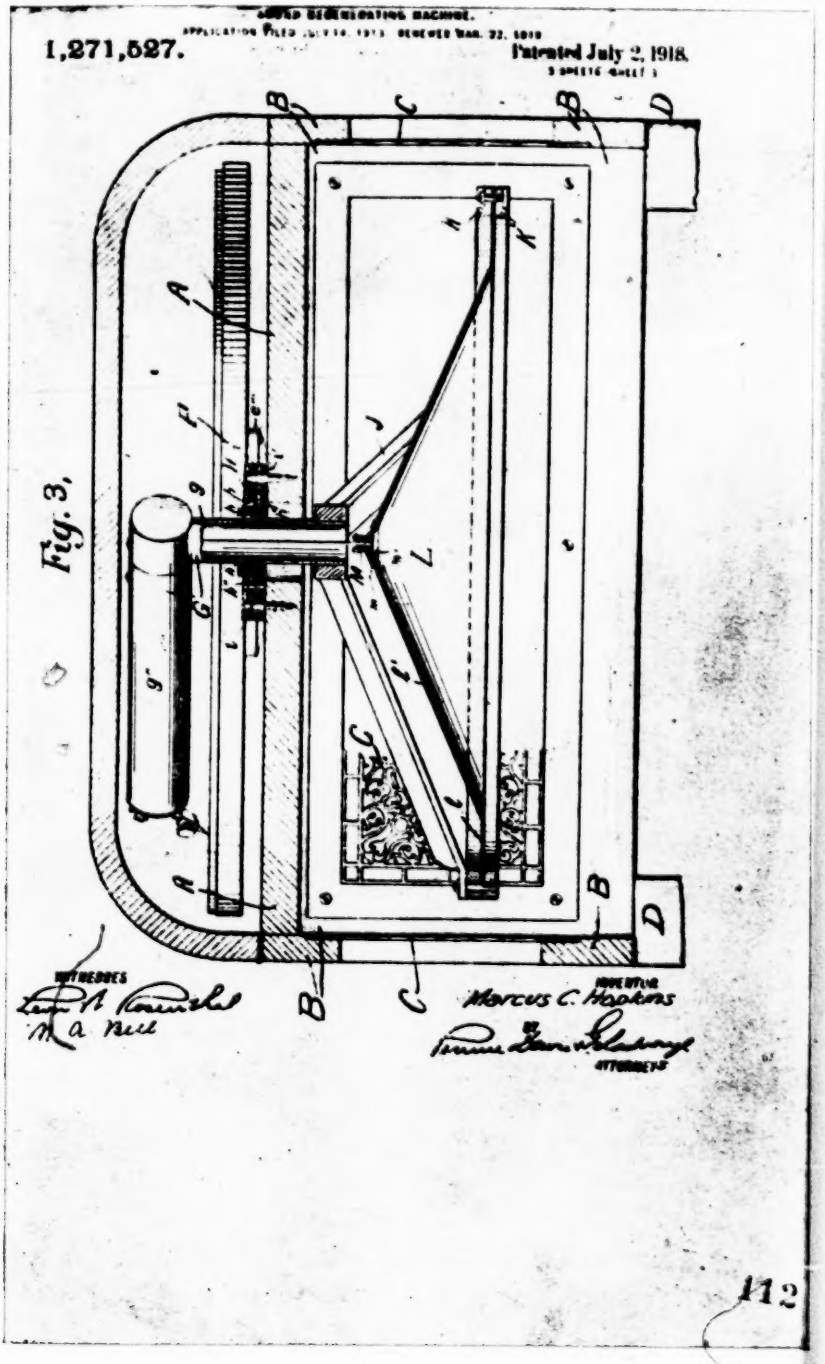
Fig. 2.

WITNESSES
M. A. Hill

INVENTOR
Marcus C. Hopkins

ATTORNEYS

111


1,271,527.
Patented July 2, 1918.
Fig. 3.
Marcus C. Hopkins
A
B
C
D

M. C. HOPKINS.

SOUND REGENERATING MACHINE.

APPLICATION FILED JULY 14, 1913. RENEWED MAR. 22, 1918.

1,271,627. Patented July 2, 1918

3 SHEETS—SHEET 1.

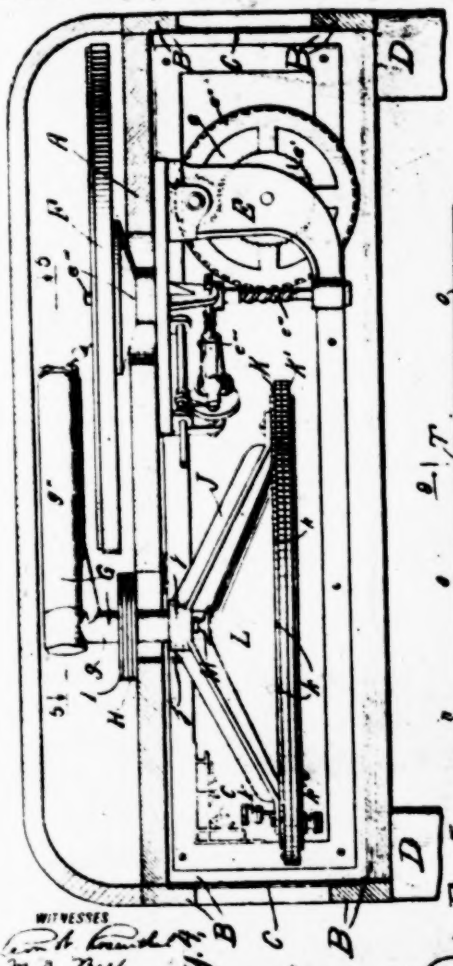


Fig. 4.

Fig. 5.

WITNESSES

INVENTOR

Marcus C. Hopkins

ATTORNEYS

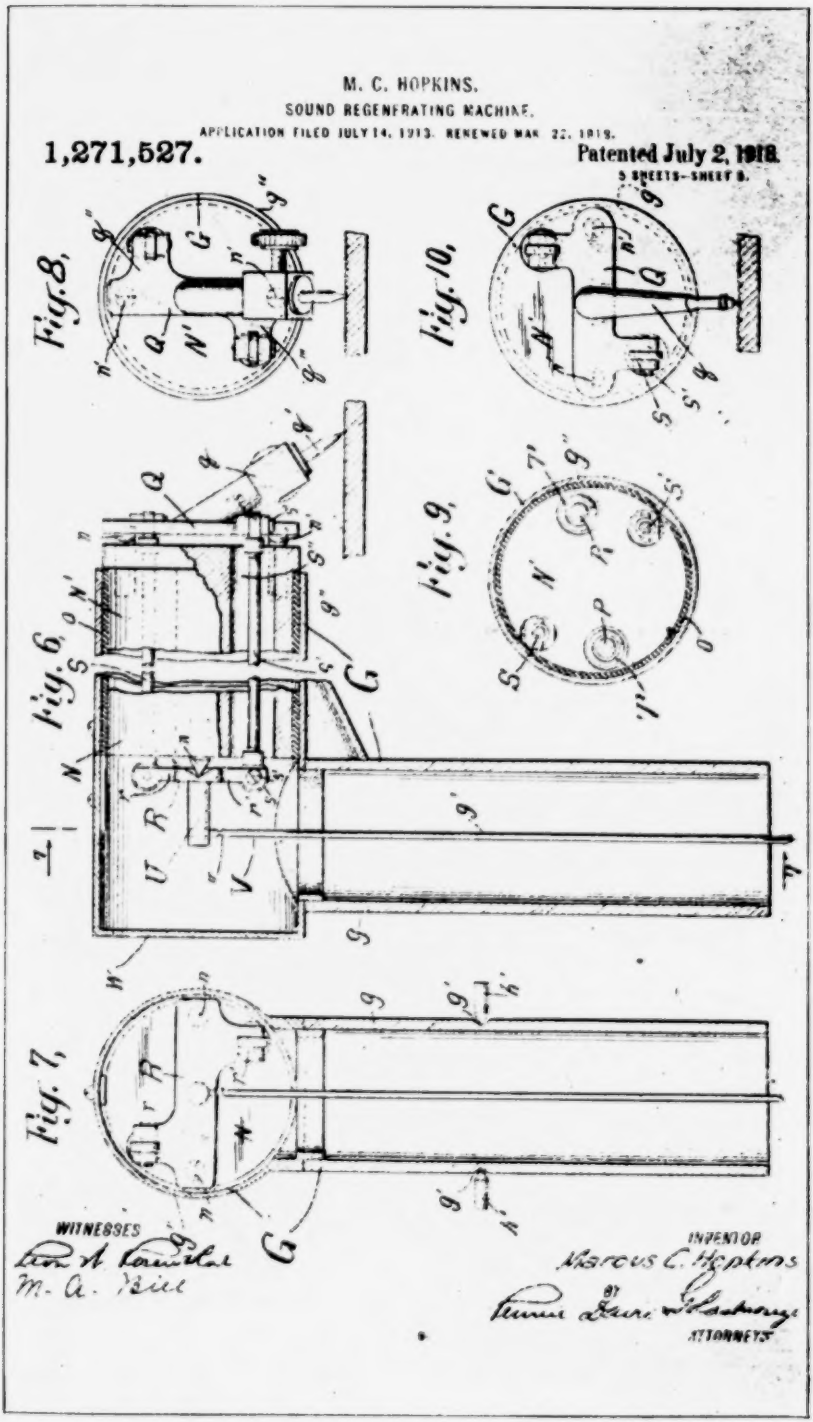
M. C. HOPKINS.

SOUND REGENERATING MACHINE.

APPLICATION FILED JULY 14, 1913. RENEWED MAR. 22, 1918.

1,271,527. Patented July 2, 1918.

5 SHEETS—SHEET 3.



[fol. 203] United States Patent Office

Marcus C. Hopkins, of Jersey City, New Jersey, Assignor, by Mesne Assignments, to Lektophone Corporation, of New York, N. Y., a corporation of Delaware.

Sound-regenerating Machine

Specification of Letters Patent

1,271,527. Patented July 2, 1918

Application filed July 14, 1913. Serial No. 778,826. Renewed March 22, 1918. Serial No. 224,048.

To all whom it may concern:

Be it known that I, Marcus C. Hopkins, a citizen of the United States, residing at No. 2859 Boulevard, Jersey City, county of Hudson, and State of New Jersey, have invented certain new and useful Improvements in Sound-Regenerating Machines; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to instruments which reproduce sounds, such as the talking machine and the phonograph, and is particularly directed to the attainment of a direct propagation in free air from a record of self-sustaining sound waves substantially corresponding to the original recorded sounds in intensity or amplitude as well as in pitch and timbre, as distinguished from an initial generation of violent air disturbances in a confined space, and a subsequent transformation of such disturbances into self-sustaining sound waves by means of the magaphone or trumpet, commonly employed with most existing machines.

The device employed to propagate such regenerated sound waves in air from a record I herein term a "regenerator," and, this device in the phonograph and talking machine comprises the "reproducer" together with the trumpet. The "reproducer" alone is incapable of generating such sound waves in air, and the violent air disturbances which are produced by this diaphragm, and which issue through its mouth piece, are almost immediately dis-

sipated in heat or in waves, which are not heard at any considerable distance if the horn be removed.

In the case of the "reproducer," all of the energy received from the record issues from its mouth as relatively violent disturbances, which are impressed upon a very small amount of free air, quite incapable of conducting such disturbances without transformation losses, and therefore the trumpet is resorted to to resist transformation into heat and to control the lateral form of the wave during a progressive spreading action, which is accompanied by a lessening of the violence of the disturbances, until a wave front of great area is attained having a movement appropriate to the sound conductivity of air. In this way it has been found practicable to transform a satisfactory part of the energy obtained from a moving record, into self-sustained sound waves in air, but in every instance this method has been accompanied by distortions of the true recorded sounds in the reproducer, and more particularly in the trumpet, giving rise to those characteristic sounds, known as phonograph and horn sounds. These distortions of the true sounds are in a measure impressed upon the record in its making, but are more noticeable in the reproduction where a suppression of character and overtones, the loss of "timbre" in instruments and the voice, and the accentuation of notes of certain pitch, so change the recorded number that a faithful reproduction is not obtained.

It is an object of the present invention to regenerate the recorded sounds directly from the record, without the interposition of a confined body of air and without the employment of a restrictive transformer, such as a horn.

The "sound regenerator" in the case of the present invention, comprises a tympanum of relatively great area freely exposed to unconfined air, in which the sounds are to be propagated and a mechanical transmission which faithfully transmits the vibrations produced by the record, to the tympanum, in such manner that the tympanum excites directly in the free air surrounding it sound waves of an intensity or amplitude substantially corresponding to the original recorded sound waves. In other words, the original sounds are directly regenerated by the vibrating tympanum without the interposition of a restrictive or sound modifying transformer.

The invention consists in providing a tympanum of novel construction, which is capable of responding to the high frequency vibrations employed in the reproduction of sounds, and of imparting these vibrations to a large body of air; in providing a suitable mounting for this tympanum to permit it to exercise its function; and in providing a vibration transmission for receiving the vibratory movement from the record and transmitting this movement to the tympanum, without change of character and appreci- [fol. 204] able loss of energy. The invention also comprehends certain combinations of parts and details of construction and location hereinafter particularly described and specifically pointed out in the appended claims.

I have illustrated in the accompanying drawings a sound reproducing machine embodying the several novel features of the invention as they may be employed in regenerating sounds from records made with either laterally or vertically sinuous grooves.

In the drawings,

Figure 1 is a plan view of the machine with the cover raised.

Fig. 2 is a vertical section on line 2—2 of Fig. 1, with cover and transmission arm raised.

Fig. 3 is a vertical section on line 3—3 of Fig. 1 with cover closed.

Fig. 4 is a vertical section on line 2—2 of Fig. 1 with cover closed and transmission arm in playing position.

Fig. 5 is a longitudinal section through the transmission arm on line 5—5 of Fig. 4.

Fig. 6 is a vertical longitudinal section through the transmission arm on line 6—6 of Fig. 5.

Fig. 7 is a vertical section on line 7—7 of Fig. 6.

Fig. 8 is an end view of the transmission arm.

Fig. 9 is a cross-section on line 9—9 of Fig. 5, and

Fig. 10 is a view similar to Fig. 8 of a modified arrangement for vertically sinuous records.

Referring to the drawings, the illustrated machine is mounted within a cabinet having a deck A upon which the motor and sound regenerator are supported. Side walls B downwardly extending from the edges of the deck

A are preferably apertured on all sides and provided with open work grilles C which afford substantially uninterrupted air paths for the sound waves from the interior of the cabinet in all directions laterally to the surrounding atmosphere. In the machine shown the cabinet is bottomless and provided with legs D at its four corners.

The motor may be of any suitable type, that shown having a frame E, spring drums e, winding gear e', spiral drive gear e'', high pitch spiral table shaft e''' and governor e''''. The frame E of the motor is secured against the under side of the deck A depending therefrom and the table shaft projects upwardly through the deck A and carries the circular record table F above the deck. The motor frame E is preferably insulated from the deck A by rubber washers not shown.

The sound regenerator has a right-angled tubular support G, the vertical arm g of which has diametrically opposite conical depressions g' which are engaged by pointed screws h' which project inwardly from and are threaded through a ring h of larger internal diameter than the external diameter of the vertical arm g of the right-angled support G. The pointed screws h' engage the depressions g' forming a horizontal axis perpendicular to the horizontal arm g'' of the right-angled support G about which axis the arm g'' can swing in a vertical plane, the vertical arm g the while being inclined within the ring h. The ring h comprises the ring h proper and an annular retaining plate h'' screwed upon the lower face of the ring h, an annular groove at the junction of the ring h and plate h'' receiving the inner edge of a holding plate H in such manner that the ring h and the right-angled support G may be turned about a vertical axis in the holding plate H.

The holding plate H is clamped between two rubber or felt rings, i, i', the lower ring i' resting upon the deck A. A ring I is placed upon the top of the upper ring i and screws i'' have their heads seated in the ring I and are screwed down into the deck A. The ring H and the rubber or felt rings i and i' have large holes through which the screws i'' pass, so that these screws do not come into contact with the ring H and the right-angled support G is therefore entirely insulated from the deck A by the rubber or felt rings. The vertical arm g of the right-angled sup-

port G extends downwardly through an aperture in the deck A at a point near the periphery of the record table F. A conical spider J shown as having three arms has its hub *j* fitted to the lower extremity of the vertical arm *g* of the right-angled support G, and is secured thereon by a set screw *j'*. To the ends of the arms of the spider J is secured by screws an annulus consisting of two ponderous rings K, K′ of metal, these two rings being clamped together by screws *k* spaced at short intervals. Two of the three arms of the said spider are screwed tightly to the rings K, K′ and the third is as tightly secured to said rings but by adjustable screws *k' k''* arranged in such manner that the rings, K, K′ can be secured at varying distances from the foot of this third leg, there being sufficient spring in the spider legs to permit of an adjustment at this point of one-quarter of an inch or so, if desired. It will be seen that owing to the proximity of the mounting of the vertical arm *g* of the right-angled support G to the edge of the record table F, the spider J and the rings K, K′ will underlie the record table and permit of a very compact arrangement of the working parts within the cabinet.

A tympanum L of light vibratile material has an annular plane peripheral portion l, the outer edge of which pe- [fol. 205] ripheral portion or supporting rim *l'* is tightly gripped and rigidly supported between the ponderous rings K, K′, and a central conical portion l′ rising from the inner edge of the annular plane peripheral portion. If satisfactory regeneration of sounds from a record is to be had, the whole diameter of the tympanum, that is, the diameter of the aperture in the rings K, K′, should exceed nine inches in order that the conditions shall be fulfilled which are required to regenerate the sound waves in the manner above described. The base of the central conical portion l′ of the tympanum should exceed in area one-half the effective area of the entire tympanum, that is, the area of the aperture in the rings K, K′; or in other words, the diameter of the base of said conical portion should be at least eight-tenths of the diameter of the circular aperture in the supporting rings K, K′. The altitude of the conical portion l′ of the tympanum should be at least one-quarter of the diameter of its base. It is, of course, possible to make some variation from the approximate sizes given without materially alter-

ing the result, but if the tympanum is made as shown in the drawings, any great variation from these proportions will be found to affect the character of the reproduction. It is of vital importance that the tympanum be made of crisp, strong material, having considerable rigidity within itself, and it is also of vital importance that the tympanum as a whole be extremely light and have as little inertia as possible without a weakening effect. The tympanum is shown of conical form with a smooth surface, and this has been found to be very satisfactory. The conical shape is given the tympanum so that shocks or vibrations impressed upon the apex of the cone in a direction toward its base will move the whole cone bodily, the strains being imparted edgewise of the material and no wave motions being set up in the thin material of the cone. The curvature of the walls of the cone preclude the setting up of waves in the material and the intended object, a simultaneous movement of the whole conical portion of the tympanum, is attained. While I prefer to construct the tympanum in the form described and shown with a smooth surface, especially in view of the ease of construction, yet it is possible to form radial corrugations in the conical portion l' and radial or concentric corrugations in the plane peripheral portion l and produce a light, stiff and very satisfactory article for the purpose. It is possible that when the tympanum is provided with corrugations as just suggested, some variation from the proportions above given may be found possible, and perhaps advisable, but such variations from the proportions given will not be great. The tympanum should preferably be constructed of a colloidal substance and should be from 3 to 20 thousandths of an inch in thickness according to the crispness or stiff character of the material used. Compressed fibrous material, such as hot pressed paper or fiber, has been found to act satisfactorily. It will be noted that the arms of the spider J incline downwardly to correspond with the conical shape of the tympanum L and that the apex of the conical portion of the tympanum is pointed upwardly toward *to* deck A of the cabinet, and that the concave side of the tympanum is open to the surrounding atmosphere through the open bottom of the cabinet, no obstructions being presented to the sound waves issuing from the concave surface of the tympanum.

A cap M is secured to the apex of the conical portion l′ of the tympanum L, and this cap should be of more rigid construction than the remainder of the tympanum and should preferably be three-eighths of an inch or more in diameter. I prefer to make the cap M of metal, extremely light but very rigid, and in the form of two cones m, m′ screwed tightly together upon opposite sides of the tympanum and gripping with their edges the material of the conical portion of the tympanum. In order that a tight and positive application of the cones forming the cap M to the conical portion of the tympanum may be had, it is preferable to form the cone m′ of lesser angle than the conical portion of the tympanum, and the cone m of greater angle than the conical portion of the tympanum in which case their edges will securely grip the tympanum material when they are secured together. The cap M is applied to the tympanum to receive the shocks which are to be applied to the tympanum as a whole, and convey them to sufficient of the material of the tympanum to insure the movement of the tympanum as a whole. This will be better understood when it is considered that if the shock were applied to paper or hard rubber at a single small point, the inertia of the tympanum as a whole would be sufficient to resist the atttack and the material would be distorted or dented at that point, the effect of the shock upon the tympanum as a whole being entirely lost. The cap M being of hard material such as metal will resist the bending action and distribute the shock to so much of the surface of the material of the tympanum as is capable of successfully resisting the shock, and it will then be transmitted to the tympanum as a whole. The plane peripheral portion l of the tympanum maintains the place of the conical active portion of the tympanum and yields sufficiently to permit of the required motion of the conical portion, resisting, however, displacement of the coni- [fol. 206] cal portion in just that degree necessary to maintain the form and neutral position of the active conical portion. Were the plane peripheral portion l of considerably greater width or markedly narrower than described, its function would be destroyed to a degree corresponding to the remoteness of the departure from the approximate proportion given and the effective portion of the conical portion of the tympanum would be proportionately lessened.

In the tubular arm g″ of the transmission support G are located two ponderous members or weights N and N′. These members N and N′ are shown as insulated from the wall of the arm g″ by a tube o of insulating material, such as soft rubber or felt. One at least of the ponderous members N and N′ must be moveable relatively to the other and therefore it cannot be rigidly secured to the support G, and the insulating material becomes necessary to avoid rattling. I preferably insulate both of the ponderous members or weights N, N′ from the wall of the transmission support G. Pins P projecting from the ponderous member N, and sliding in holes in the other ponderous member N′, act as guides and prevent disalinement and angular displacement of the moveable ponderous member. Knife edge fulcra n and n′ are secured in and project from the ends of the ponderous members N and N′ and in the form of the device shown in Figs. 1 to 9 the fulcra n are arranged horizontally and the fulcra n′ are arranged vertically. A lever Q is mounted on the fulcra n′ and is capable of movement upon a vertical axis. A style holder q projects from the lever Q downwardly at an incline so that the point of a style q′ held in the style holder is considerably removed from the axis of the lever Q and movement given the style q′ by the record will effect an oscillation of the lever Q about its vertical axis upon the fulcra n′. The lever Q has arms q″ and q‴ projecting from opposite sides thereof, the arm q″ being near the top of the lever Q and the arm q‴ being near the bottom of said lever. The reason for this arrangement of the arms upon the lever will presently appear.

A lever R is mounted upon the fulcra n and oscillates upon a horizontal axis. This lever has arms r and r′ extending upwardly and downwardly from its opposite sides, the arm r projecting from a point near one end of the lever R, and the arm r′ projecting from a point near the other end of the lever R. It will now be seen that a point upon the arm r of the lever R is opposite a similar point on the arm q″ of the lever Q and these two points are connected by rod link S. It will also be seen that a point upon the arm r′ of the lever R is opposite a point upon the arm q‴ of the lever Q, and these two points are connected by a rod link S′. The rod links S and S′ have eye-ends arranged in planes removed 90° from one another, and these eye-ends s are en-

gaged by pivot screws s′ upon the arms of the levers Q and R. A parallelogram is formed by the levers Q and R and the rod links S and S′ and in the form just described, which is adapted for a laterally sinuous groove in the record, oscillation of the lever Q about a vertical axis will produce like oscillations of the lever R about a horizontal axis. Spring T preferably mounted upon the pins P press the ponderous members N and N′ apart forcing the knife edge fulcra n and n′ tightly against the levers R and Q, and put the parallelogram of levers and links under tension, precluding any rattle or looseness of the levers upon the fulcra or of the eye-ends of the links upon their pivot screws, and as the movable ponderous member of the combination is insulated from the transmission support G, no rattle or displacement of the parts can take place when the record groove oscillates the lever Q, but such oscillation will be faithfully transmitted to the lever R. The ponderous members N and N′ have clearance holes s″ for the rod links S and S′.

An arm U projects from the central portion of the lever R and to its end is rigidly secured a rod V which extends downwardly through the interior of the arm g of the transmission support G, its lower end being rigidly secured to the cap M of the tympanum. The rod V is nicked or thinned at r close to the arm U of the lever R to permit of a slight springing action which compensates for the very slight angular motion of the arm U when the lever R is oscillated. It will now be seen that the oscillation of the lever R about its horizontal axis imparted to it from the lever Q, will effect an endwise vibration of the rod V which is directly impressed upon the tympanum L. A cap W closes the opening at the angle of the transmission support G and the removal of this cap gives access to the working parts of the rear end of the transmission.

It will be noted that the distance between the point of the style q′ and the axis of the lever Q is greater than the length of the arm U which projects from the center of the lever R and to which the rod V is connected. By reason of this fact, and of the fact that the levers Q and R, and the rod links S, S′ form a parallelogram, the length of vibration of the tympanum is relatively much less than that of the style, and the tympanum thus offers little resistance to the movement of the style, thereby greatly reducing the

wear on the record. To compensate for this small movement of the tympanum, its large area enables it to move a large body of air, so as to obtain sound waves of large volume and great carrying power.

When a vertically sinuous record is employed the lever Q [fol. 207] is mounted to oscillate about a horizontal axis, as shown in Fig. 10, no change in the lever R being required.

Having thus described my invention, what I claim and desire to secure by Letters Patent, is:—

1. In a machine for directly regenerating sound from a record of the same, a vibratile conical tympanum of large area rigidly supported at its periphery and freely exposed to unconfined air, and a mechanical transmission through which the vibrations produced by the record are transmitted to the tympanum, the tympanum being of sufficient area to impart to the surrounding free air, when the tympanum is so vibrated, sound waves subtantially corresponding in intensity to the recorded sound waves; substantially as described.

2. In a machine for directly regenerating sound from a record of the same, a vibratile conical tympanum of large area rigidly supported at its periphery and freely exposed to unconfined air, a mechanical transmission through which the vibrations produced by the record are transmitted to the tympanum, the tympanum being of sufficient area to impart to the surrounding free air, when the tympanum is so vibrated, sound waves substantially corresponding in intensity to the recorded sound waves, and an open-work cabinet inclosing the tympanum but affording substantially free access of the surrounding air thereto; substantially as described.

3. In a direct sound regenerating machine, the combination of a record holder, a transmission support mounted to swing over said record holder, and a tympanum carried by said support and extending under said record holder; substantially as described.

4. In a direct sound regenerating machine, the combination with a record holder, of a transmission support mounted to swing about vertical and horizontal axes, said support having an arm extended to move above and across said record holder and adapted to carrying a stylus, the support having a second arm having a free end, and a tympanum carried at the free end of said second arm with its

axis at an angle to said first arm; substantially as described.

5. In a sound regenerating machine, a vibration transmission comprising two ponderous members, fulcra carried by said members, an articulate parallelogram having opposite sides mounted on said fulcra and means exerting pressure upon said ponderous members to place said parallelogram under tension; substantially as described.

6. In a sound regenerating machine, a vibration transmission comprising two ponderous members, fulcra carried by said members, an articulate paralellogram of non-extensible links and non-flexible levers, the levers of said parallelogram being mounted on said fulcra, and means exerting pressure upon said ponderous members to place said paralellogram under tension; substantially as described.

7. In a machine for directly regenerating sound from a record of the same, a tympanum support having a circular aperture, a light vibratile tympanum of long area having its outer edge rigidly mounted in said support, said tympanum being shaped to provide an annular sustaining rim adjacent said support, and a conical portion springing from the inner edge of said annular rim, a cap of non-vibratile material rigidly secured to the apex of said conical portion of said tympanum, and a mechanical transmission through which the vibrations produced by the record are transmitted to the tympanum, the tympanum being of sufficient area to impart to the surrounding free air, when the tympanum is so vibrated, sound waves substantially corresponding in intensity to the recorded sound waves; substantially as described.

8. In a machine for directly renegerating sound from a record of the same, a ponderous tympanum support having a circular aperture, a light tympanum of long area having its outer edge rigidly mounted upon said support in said aperture, said tympanum having a central conical portion, the base of which exceeds in area one half the effective area of the said tympanum and a mechanical transmission through which the vibrations produced by the record are transmitted to the tympanum, the tympanum being of sufficient area to impart to the surrounding free air, when the tympanum is so vibrated, sound waves substantially corresponding in intensity to the recorded sound waves; substantially as described.

9. In a machine for directly renegerating sound from a record of the same, a ponderous tympanum support having a circular aperture, a light vibratile tympanum exceeding nine inches in diameter, having its outer edge rigidly mounted on said support, said tympanum being shaped to provide an annular rim adjacent said support, and a conical portion springing from the inner edge of said annular rim, a cap of non-vibratile material rigidly secured to the apex of said conical portion of said tympanum, and a mechanical transmission through which the vibrations produced by the record are transmitted to the tympanum, whereby the tympanum imparts to the surrounding free air sound waves substantially corresponding in intensity to the recorded sound waves; substantially as described.

10. In a machine for directly renegerating sound from a record of the same, a ponderous tympanum support having [fol. 208] a circular aperture exceeding nine inches in diameter, a light vibratile tympanum mounted in said aperture and having its outer edge rigidly secured upon said support, said tympanum being shaped to provide an annular rim adjacent said support, and a conical portion springing from the inner edge of said annular rim, the diameter of the base of said conical portion being not less than eight-tenths of the diameter of the said circular aperture in said support, a cap of non-vibratile material rigidly secured to the apex of said conical portion of said tympanum, and a mechanical transmission through which the vibrations produced by the record are transmitted to the tympanum, the tympanum being of sufficient area to impart to the surrounding free air, when the tympanum is so vibrated, sound waves substantially corresponding in intensity to the recorded sound waves; substantially as described.

11. In a machine for directly regenerating sound from a record of the same, a ponderous tympanum support having a circular aperture, a light vibratile tympanum of long area mounted in said aperture, and having its outer edge rigidly secured to said support, said tympanum being shaped to provide an annular rim adjacent said support, the outer diameter of said rim exceeding nine inches, and a conical portion springing from the inner edge of said annular rim, the altitude of said conical portion being substantially one-fourth of the diameter of its base, a cap of non-vibratile material rigidly secured to the apex of said conical portion

of said tympanum, and a mechanical transmission through which the vibrations produced by the record are transmitted to the tympanum, the tympanum being of sufficient area to impart to the surrounding free air, when the tympanum is so vibrated, sound waves substantially corresponding in intensity to the recorded sound waves; substantially as described.

12. In a machine for directly regenerating sound from a record of the same, a ponderous tympanum support having a circular aperture exceeding nine inches in diameter, a light vibratile tympanum mounted in said aperture, and having its outer edge rigidly secured to said support, said tympanum being shaped to provide an annular rim adjacent said support, and a conical portion springing from the inner edge of said annular rim, the diameter of the base of said conical portion being not less than eight-tenths of the diameter of said circular aperture in said support, and the altitude of said conical portion being substantially one quarter of the diameter of its base, a cap of non-vibratile material rigidly secured to the apex of said conical portion of said tympanum, and a mechanical transmission through which the vibrations produced by the record are transmitted to the tympanum, whereby the tympanum imparts to the surrounding free air sound waves substantially corresponding in intensity to the recorded sound waves; substantially as described.

13. In a sound regenerating machine, a vibration transmission comprising two ponderous members, fulcra carried by said members, an articulate parallelogram of links and levers, the levers of said parallelogram mounted upon said fulcra, pressure exerting means acting between said members and tending through said fulcra to hold said parallelogram under tension, and a style holder carried by one of said levers; substantially as described.

14. In a sound regenerating machine, a vibration transmission comprising two ponderous members, guides for maintaining the relative positions of said members, fulcra carried by said members, an articulate parallelogram of links and levers, the levers of said parellelogram mounted upon said fulcra, pressure exerting means acting between said members and tending through said fulcra to hold said parallelogram under tension, and a style holder carried by one of said levers; substantially as described.

15. In a sound regenerating machine, a vibration transmission comprising two ponderous members, guides for maintaining the relative positions of said members, fulcra carried by said members, an articulate parallelogram of links and levers, the levers of said parallelogram mounted upon said fulcra, pressure exerting means acting between said members and tending through said fulcra to hold said parallelogram under tension, and a style holder carried by one of said levers; substantially as described.

16. In a sound regenerating machine, a vibration transmission comprising two ponderous members, a vertical fulcrum on one of said members, a horizontal fulcrum on the other of said members, an articulate parallelogram of links and levers, the levers of said parallelogram mounted upon said fulcra, and pressure exerting means acting between said members and tending through said fulcra to hold said parallelogram under tension; substantially as described.

17. In a sound regenerating machine, a vibration transmission comprising two ponderous members, fulcra carried by said members, an articulate parallelogram of links and levers, the levers of said parallelogram mounted upon said fulcra, pressure exerting means acting between said members and tending through said fulcra to hold said parallelogram under tension, a style-holder carried by one of said levers, a direct sound regenerating tympanum connected to another of said levers and a pivoted support for said transmission and said tympanum; substantially as described.

[fol. 209] 18. In a sound regenerating machine, a vibration transmission comprising a support, two ponderous members carried by said support, one of said members being movable upon said support, insulating material between said movable member and said support, fulcra carried by said members, an articulate parallelogram of links and levers, said levers being mounted on said fulcra and pressure exerting means acting between said members and tending through said fulcra to hold said parallelogram under tension; substantially as described.

19. In a direct sound regenerating machine, the combination of a bottomless cabinet having apertures on all sides and a horizontal partition therein, a record holder mounted upon and above said partition, a motor for driving said record holder, a right angled transmission support mounted to swing upon horizontal and vertical axes upon said par-

tition adjacent the periphery of said record holder, one arm of said support adapted to be swung over said record holder, and the other arm of said support extending downwardly through said partition, a vibration transmission mounted within and insulated from said transmission support and comprising two ponderous members carrying fulcra, a parallelogram of links and levers, said levers mounted upon said fulcra, pressure exerting means acting between said members and tending through said fulcra to hold said parallelogram under tension, a style-holder carried by one of said levers at the outer end of said transmission support, a spider mounted upon said transmission support below said partition, a ponderous tympanum support carried by said spider, a direct sound regenerating tympanum mounted upon said ponderous tympanum support, said tympanum being of light vibratile material and having a conical form throughout the greater part of its area and a positive connection between the apex of the conical portion of said tympanum and the inner end of the parallellogram of the said vibration transmission; substantially as described.

20. In a sound regenerating machine, a tympanum, a vibration transmission tensioned in the direction of its vibration independently of the tympanum and connected therewith, and a style holder connected with said transmission.

21. In a sound regenerating machine, an untensioned tympanum, a vibration transmission tensioned in the direction of its vibration and connected with said tympanum, and a style holder connected with said transmission.

22. In a sound regenerating machine, a tympanum, an oscillatory transmission member connected therewith, a style holder for oscillating the transmission member, and means independent of the tympanum for tensioning the transmission member in the direction of its oscillatory movement.

23. In a sound regenerating machine, a tympanum, an oscillatory transmission member connected therewith, a style holder for oscillating said member, and means independent of the tympanum for yieldingly imparting a tension to said member in the direction of its oscillatory movement.

24. In a sound regenerating machine, an untensioned tympanum, a transmission member connected therewith

and adapted for oscillation, a style holder for oscillating said member, and means for imparting a tension to said member in the direction of its oscillatory movement.

25. In a sound regenerating machine, a style holder, a tympanum having a rigid vibratory portion, and a tensioned transmission connecting the style holder with said rigid portion, the tension of said transmission being in the direction of its vibration and independent of the tympanum.

26. In a sound regenerating machine, a style, a tympanum, and tensioned transmission means connecting the style and tympanum and having means for imparting vibrations to the tympanum having no greater length than the vibrations of the style, the tension of said transmission beng in the direction of its vibrations and independent of the tympanum.

27. In a sound regenerating machine, a tympanum having a vibratile area of sufficient size to effect, without amplification, the regeneration from a record of sound waves of relatively large volume and carrying power, and tensioned vibration transmitting means connected to the tympanum and adapted to be actuated by a style, the tension of the transmission being in the direction of its vibration and not extending to the tympanum.

28. In a sound regenerating machine, a tensioned vibration transmission, a style-holder upon one end of said transmission and an untensioned tympanum connected with the opposite end of said transmission, the tension of the transmission being in the direction of its vibration; substantially as described.

29. In a sound-regenerating machine, a vibratile conical tympanum of large area rigidly supported at its periphery and freely exposed to unconfined air, a sound-vibrated element, and vibration transmission means connecting said element and said tympanum and arranged to impart to the tympanum vibrations which are relatively much shorter than the vibrations imparted to the said element.

30. In a sound-regenerating machine, a vibratile conical tympanum rigidly supported at its periphery and freely ex- [fol. 210] posed to unconfined air, a sound-vibrated element, and vibration transmission means connecting said element and said tympanum arranged to impart to the tympanum vibrations which are relatively much shorter than

the vibrations imparted to the said element; the tympanum having an area sufficiently large to effect, without amplification, sound waves of large volume and carrying power.

31. In a sound-regenerating machine, a vibratile conical tympanum of large area, rigidly supported at its periphery and freely exposed to unconfined air, a sound-vibrated element, and tensioned transmission means connecting said element and said tympanum and arranged to impart to the tympanum vibrations which are relatively much shorter than the vibrations imparted to the record end of the style.

In testimony whereof I affix my signature, in presence of two witnesses.

Marcus C. Hopkins.

Witnesses: M. A. Bill, Leon W. Rosenthal.

Corrections in Letters Patent No. 1,271,527

It is hereby certified that in Letters Patent No. 1,271,527, granted July 2, 1918, upon the application of Marcus C. Hopkins, of Jersey City, New Jersey, for an improvement in "Sound-Regenerating Machines," errors appear in the printed specification requiring correction as follows: Page 1, line 25, for the word "magaphone" read *megaphone;* page 5, lines 75 and 95, claims 7 and 8, and page 6, line 25, claim 11, for the word "long" read *large;* and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 28th day of September, A. D., 1920.

M. H. Coulston, Acting Commissioner of Patents.
(Seal.)

Cl. 274—16.

[fol. 211] 2—421

1913

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3. Amdt. A. & Sup. Oaths, Dec. 24/13.

4. Rej. Feb. 7, 1914.
5. Amdt. B. Feb. 6/15.
6. Rej. Feb. 23, 1915.
7. Amdt. C. Feb. 23/16.
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9. Amdt. I. Mar. 28/16.
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11. Amdt. E. Apl. 6/16.
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13. Amdt. F. 3/29/18.
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15. Letter (per address) 4/18/18.
16. Amdt. G. 4/18/18.
17. Notice of Suit—Nov. 12—1924.
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19. Notice of Suit—May 26—1925.
20. Notice of Suit—Nov. 3—1925.
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M. C. HOPKINS.

SOUND REGENERATING MACHINE.

APPLICATION FILED JULY 14, 1913. RENEWED MAR. 22, 1918.

1,271,527. Patented July 2, 1918.

3 SHEETS—SHEET 1.

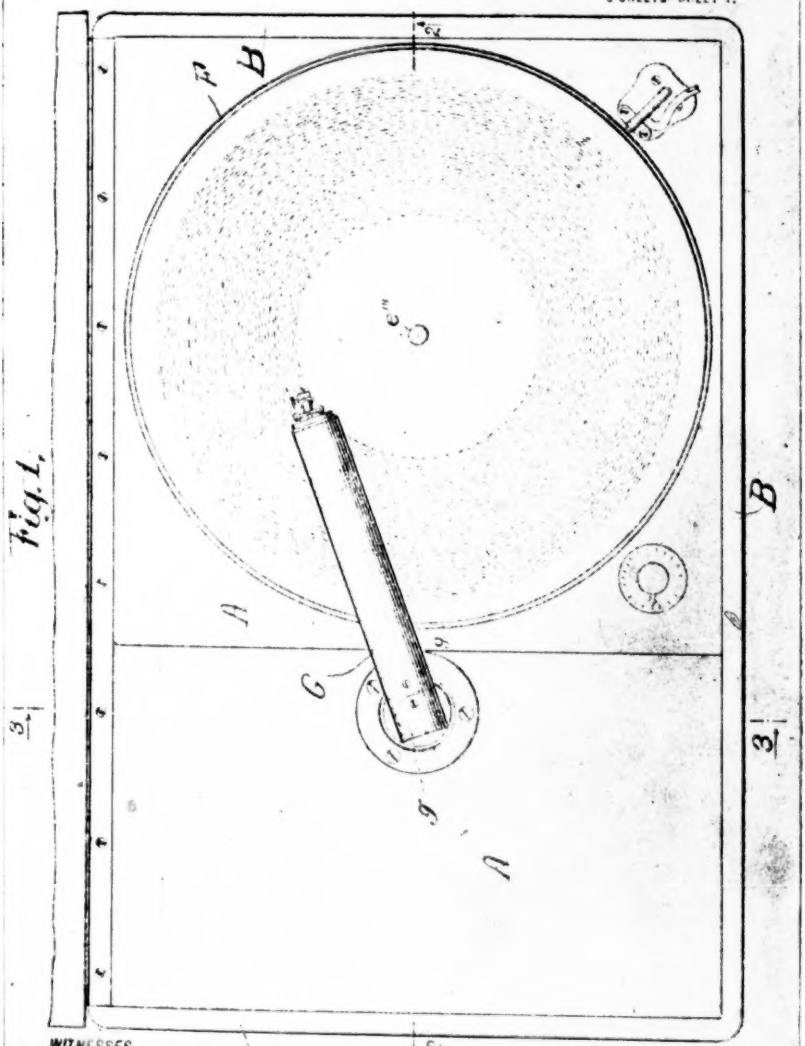
Fig. 1.
B
B
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3 SHEETS—SHEET 2

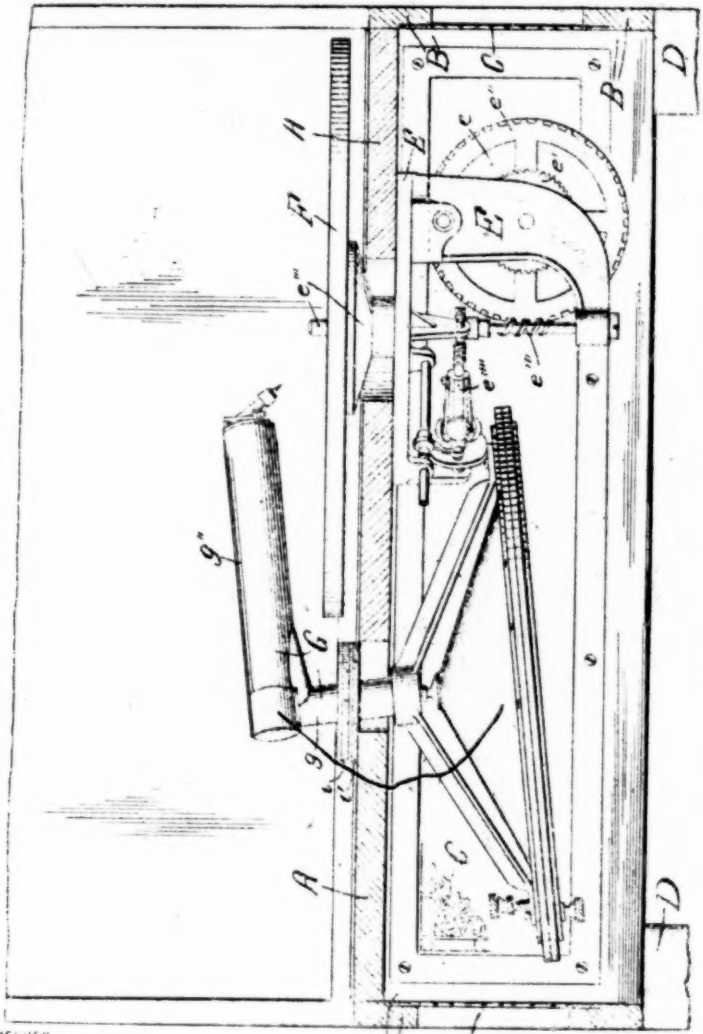

Fig. 2.

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3 SHEETS-SHEET 3.

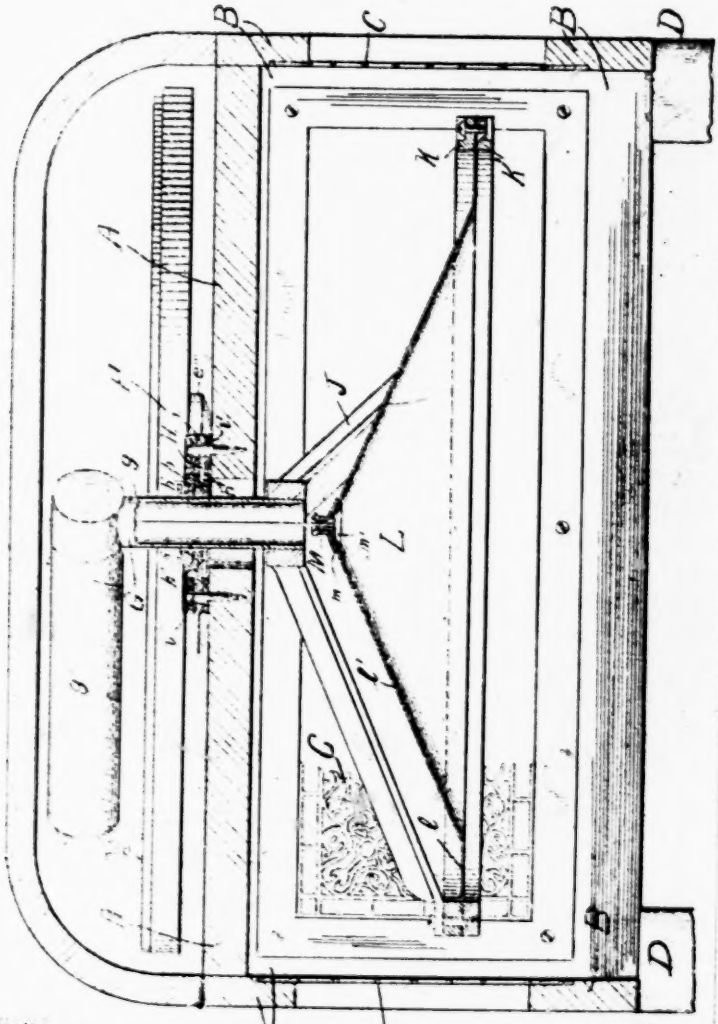

Fig. 3.

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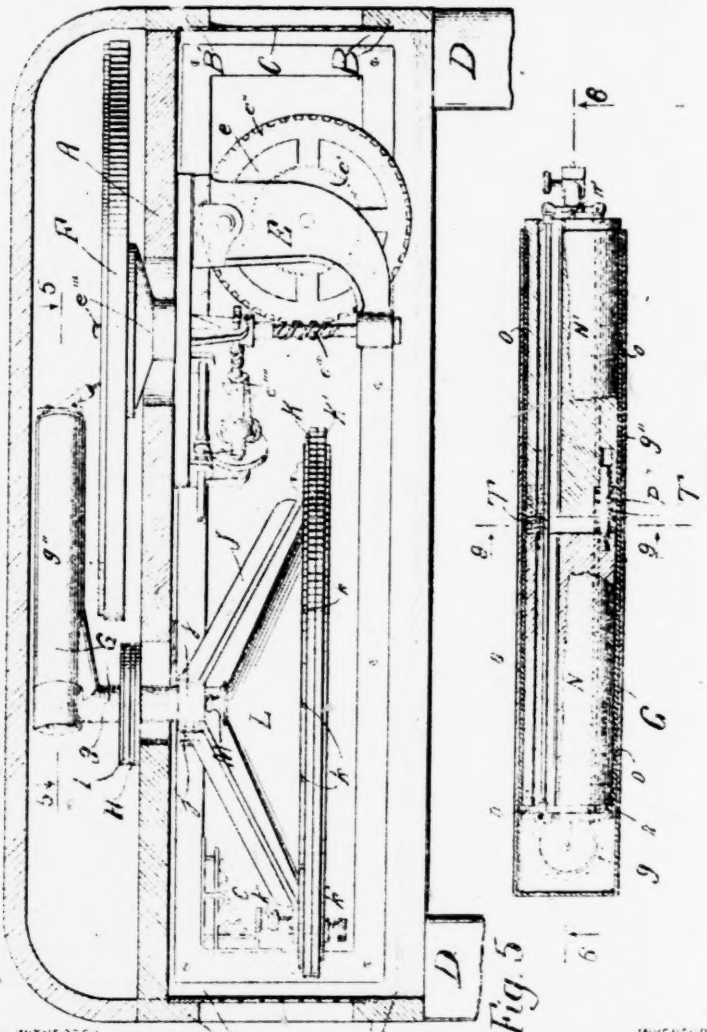

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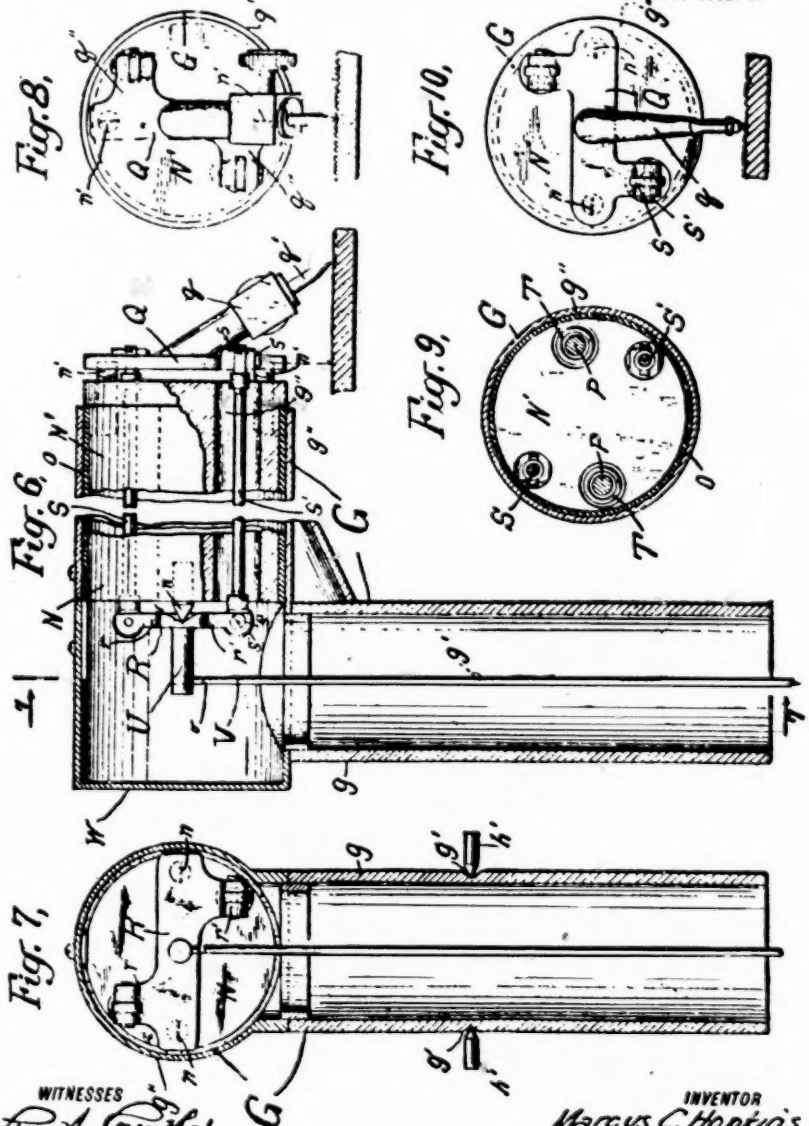
APPLICATION FILED JULY 14, 1913. RENEWED MAR. 22, 1918.

1,271,527. Patented July 2, 1918.

3 SHEETS—SHEET 3.



WITNESSES

Leon A. Lamirale

M. A. Bill

INVENTOR

Marcus C. Hopkins

BY

Munn Davis & Glasberg

ATTORNEYS

46. .....
47. .....
48. .....
49. .....
50. .....

778826—108

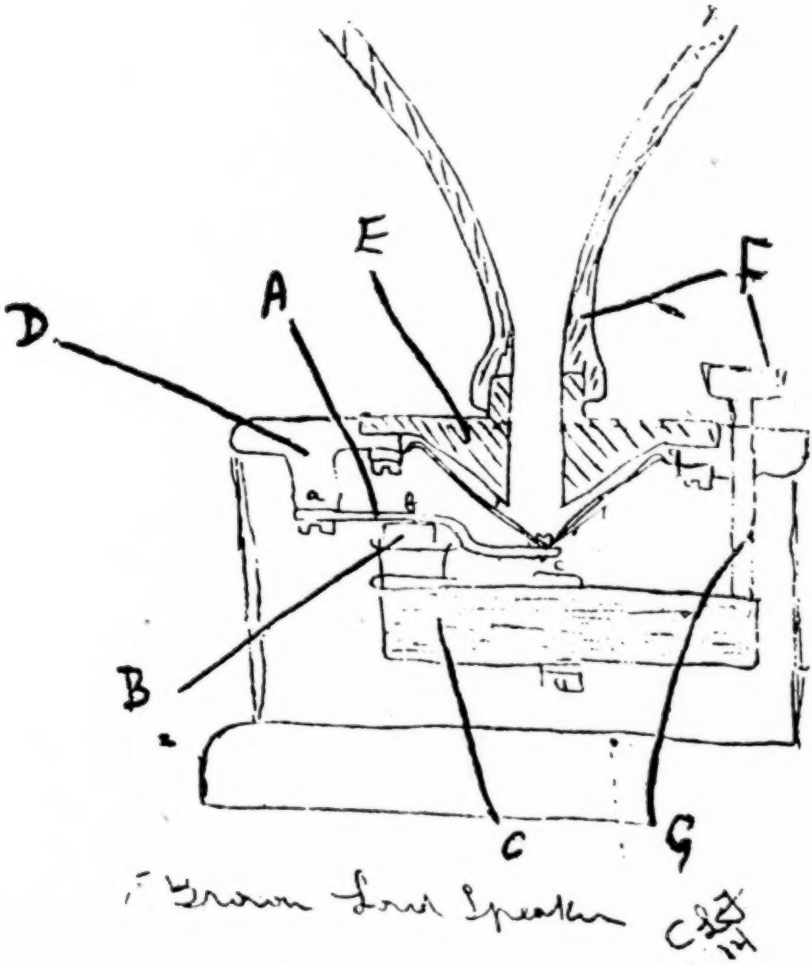
(Here follow drawings, side folios 213, 214, 215, 216, and 217)

[fol. 218] [Endorsed:] No. 1726. United States District Court. Lektophone vs. Rola. Pltfs. Exhibit No. 7. Filed 5/10/28. Walter B. Maling, Clerk. By A. C. Aurich, Deputy Clerk.

No. 5712. United States Circuit Court of Appeals for the Ninth Circuit. Filed Feb. 5, 1929. Paul P. O'Brien, Clerk.

[fol. 219] PLAINTIFF'S EXHIBIT No. 25

PLAINTIFFS EXHIBIT P 17



[Endorsed:] No. 1726. United States District Court. Lektophone vs. Rola. Pltfs. Exhibit No. 25. Filed 5/11/28. Walter B. Maling, Clerk. By A. C. Aurich, Deputy Clerk.

No. 5712. United States Circuit Court of Appeals for the Ninth Circuit. Filed Feb. 5, 1929. Paul P. O'Brien, Clerk.

[fol. 220] DEFENDANT'S EXHIBIT No. 9

[Endorsed:] No. 1726. United States District Court. Lektophone vs. Rola. Defendant's Exhibit No. 9. Filed

5/10/28. Walter B. Maling, Clerk. By A. C. Aurich, Deputy Clerk. No. 5712. United States Circuit Court of Appeals for the Ninth Circuit. Filed Feb. 5, 1929. Paul P. O'Brien, Clerk. Lektophone vs. Rola.

Copies of Patents Set Up in Answer

United States Patents

Number.	Date.	Patentee.
216,051	June 3, 1879	Maxwell
252,024	Jan. 10, 1882	Farrington
254,642	Mar. 7, 1882	Hale
599,867	Mar. 1, 1898	Rogers
654,360	July 24, 1900	Schopf
674,575	May 21, 1901	Duwelius
822,024	May 29, 1906	Shanks
857,209	June 18, 1907	Smith
890,142	June 9, 1908	Kraemer
963,362	July 5, 1910	Edison
986,477	Mar. 14, 1911	Lumiere
1,036,529	Aug. 20, 1912	Lumiere
1,064,062	June 10, 1913	English
1,096,676	May 12, 1914	Brown
1,180,401	Apr. 25, 1916	Johnson
1,182,078	May 9, 1916	Elfering
1,192,289	July 25, 1916	English

[fol. 221]

British Patents

Number.	Date.	Patentee.
9,712	1898	Lodge
9,418	1899	Stroh
3,393	1901	Stroh
15,060	1904	Simon, et al.
8,011	1906	Szek, et al.
8,833	1907	Hough
1,194	1908	Curteis
17,827	1909	Zappert
26,738	1909	Rosenthal
15,675	1910	Lyons
29,833	1910	Rogers
1,157	1911	Brown

French Patents

Number.	Date.	Patentee.
127,180	1878	Ader
331,226	1903	Gaumont et Cie.
362,926	1906	Welton
397,609	1908	Persichetti

German Patents

183,685	1906	Muller
220,412	1909	Otto

"Talking Machine News," title page and pages 243 and 244.

(Here follows drawing, side folio 222)

[fol. 223] United States Patent Office

Joseph W. Maxwell, of Louisville, Kentucky

Improvement in Mechanical Telephones

Specification Forming Part of Letters Patent No. 216,051, Dated June 3, 1879; Application Filed November 7, 1878

To all whom it may concern:

Be it known that I, Joseph W. Maxwell, of the city of Louisville, county of Jefferson, and State of Kentucky, have invented certain Improvements in Telephony, of which the following is a specification.

Whereas in an application made by myself for Letters Patent of the United States, filed in the United States Patent Office on the 14th day of October, 1878, for improvement in telephony, I have shown and described an apparatus (among other things) consisting of two sounding-boards and their vibrators, of the same construction and material, placed together apex to apex, apart a few inches only, on the same transmitting-wire, and connected together by another short wire, which extends from the apex of one to the apex of the other, the means of fastening being knots formed on the extremities of the short wire after they had been extended through the vibrators; one apparatus consisting of this

J. W. MAXWELL.
Mechanical-Telephone.

No. 216,051. Patented June 3, 1879.

Fig. 1.

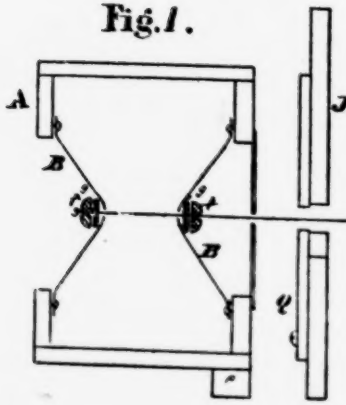
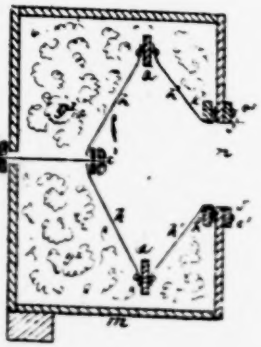


Fig. 2.



Witnesses.
A. M. Stout
F. B. Webb

Inventor,
J. W. Maxwell.

combination of parts is placed at each end of a long transmitting-wire, which is passed through the centers of the vibrators, and over and along which vibrations of air or sounds are transmitted from one end of the line to the other, and each apparatus is held to its connection with the wire by a button on each end thereof, and the wire is held taut or otherwise, as the one apparatus may be moved to or from the other.

The sounding-boards may be made of soft pine wood, or any other suitable material, and should have openings in their central portions, over which the vibrators are to be fastened, and should be mounted upon suitable supports or inclosed in suitable boxes, and should be made quite thin, in order to increase their capacity for vibration; and the vibrators are made of sheep-skin or like material, and should be fastened upon the sounding-boards over the openings therein while in a wet and plastic condition, and then have their central portions drawn out and stretched until they assume a funnel-like form, and then be allowed to dry and retain that form.

Now my invention herein claimed relates to the construction of a vibratory apparatus of quite different form and of a much better result from the one hereinbefore described.

It consists, to some extent, of an inclosing-box, within which the vibrators are operated, the box having a suitable opening in and through the end of it which is opposite to the other end of the line of communication, into which vibrations are received and out of which they are delivered; but the apparatus proper consists of two diaphragms of vibrators of the same material before mentioned, and one of them of exactly the same form, and the other of the same general form, but having a central opening in it, to correspond in form and size with the one in the end of the containing-box before mentioned; and these two vibrators, which are in a circular form, by their outer edges are fastened to and upon the two opposite sides of a thin board of soft pine wood, or other vibratory wood or material, with their concave sides next to each other, and the board is cut away in the center, so as to leave a large opening in circular form in it, and the residue of the board serves as a frame for the two vibrators to hold their outer edges distended, and it does not touch the containing-box at all; and the one of the vibrators having the opening in it has the

edge around the opening fastened upon another board, which has also an opening in it, corresponding in size and form with the one in the vibrator and the one in the end of the containing-box, and the board is attached to the inside of the end of the box, so that the openings in the vibrator, board, and box constitute an avenue for the reception and delivery of air-vibrations into and out of the apparatus. The transmitting-wire is passed in through the opposite end of the box, and through the apex of the vibrator that has no central opening in it, and is there held by a button on the end of it on the inside of the vibrator, and when the wire is stretched taut both vibrators are stretched and held taut likewise, and the whole apparatus is held suspended upon the wire at one apex, and the attachment to the board (which is attached to the end of the box) at the other, and the result of this construction is a high degree of vibratory power.

My said invention will be more particularly described with reference to the accompanying drawings, in which Figure 1 represents a central vertical longitudinal section of the said apparatus described in my said application filed [fol. 224] October 22, 1878; and Fig. 2, a like view of the containing box and operative parts of this my improvement claimed herein.

In Fig. 2, a indicates the board to which the outer edges of the vibrators are fastened; h, the vibrator, attached to the transmitting-wire T by the button e and h'; the other one of said vibrators, and the same which has the central opening, n, in it; and k, the board to which that vibrator is attached by the edge around its opening, and it is fastened upon the inside of the end of the box, so that the opening at n is through vibrator, board, and box. g' indicates the cotton or wool placed around the vibrators within the box, in order to destroy the ring of the wire T. The vibrators are stretched and held taut by means of the button e on the wire T; and but for the button i on the wire outside of the box the vibrators would collapse when the wire was relaxed.

In this construction it will be observed that a large portion of the apparatus is made of the sheep-skin or other animal membrane, and there is in it no more of wood, which is itself capable of a high degree of vibration, than enough for a frame to hold the vibrators in position and proper shape, and that it is therefore very efficient for the

(No Model.)

G. K. & H. C. FARRINGTON.

MECHANICAL TELEPHONE.

No. 252,024. Patented Jan. 10, 1882

Fig. 1.

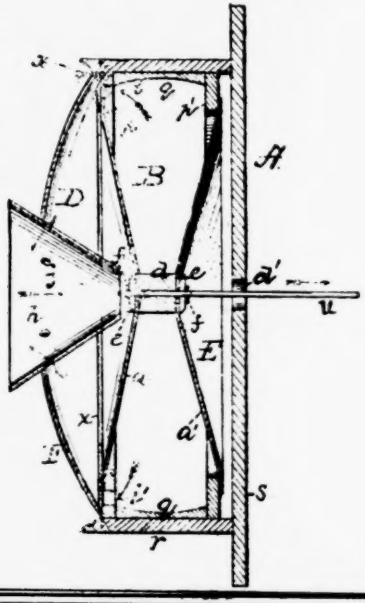
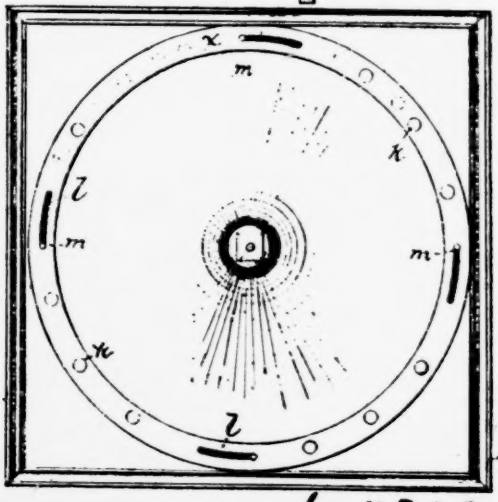


Fig. 2.



Witnesses:
S. Whitfield
A. G. Hopkinson

Inventors:
George K. Farrington
Homer C. Farrington.
by Wm Prescott Hyde
attys.

purpose of condensing and strengthening air-vibrations for transmission, and I have found it to be so by actual experiment, much more so than the one shown in Fig. 1.

I have found also by experiment that a vibrator that is from seven to eight inches in diameter through the center from one outer edge to the other is the most efficient, and that when they are much smaller than this the vibrations made by the vocal organs are of a nasal character; but when an apparatus of proper size is used at one end of the line, then a much smaller one may be used at the other without impairing perceptibly the effect.

A very good effect is secured by using the construction shown in Fig. 2 at one end of the line, and that shown in Fig. 1 at the other.

What I claim as my invention, and desire to secure by Letters Patent, is—

The vibratory apparatus composed of the vibrator h and the vibrator h′, having the opening n, and the suspended board a and the fixed board k′, constructed and arranged substantially as and for the purpose described.

J. W. Maxwell.

Witnesses: I. M. Stephens, A. M. Stout

(Here follows drawing, side folio 225)

[fol. 226] United States Patent Office

George K. Farrington and Homer C. Farrington, of Kirksville, Missouri, Assignors of One-third to Bradford S. Potter, of Shippensburg, Pennsylvania

Mechanical Telephone

Specification Forming Part of Letters Patent No. 252,024, Dated January 10, 1882. Application Filed September 14, 1881. (No model.)

To all whom it may concern:

Be it known that we, George K. Farrington and Homer C. Farrington, citizens of the United States of America, residing at Kirksville, in the county of Adair and State of Missouri, have invented certain new and useful Improvements in Mechanical Telephones, of which the following is a speci-

fication, reference being had therein to the accompanying drawings.

Figure 1 is a vertical section of our improved telephone; Fig. 2, a front view of the same with the sound-collector and mouth-piece removed.

Like letters refer to like parts in each figure.

This invention relates to improvements in the class of telephones termed "mechanical," in which the transmission of a sound-wave or tone depends entirely upon the vibration of the sound-wave conducted by wire or other substance.

It is a well-established fact in physics that if two tuning-forks having the same pitch stand near each other and one be made to vibrate the other will vibrate also, giving forth the same note or tone, because it responds readily to corresponding wave-lengths in the air; but if they have a different pitch or are not in unison and are placed in the same position and one be made to vibrate the other will not respond, because it does not vibrate with the same wave as the air or sound wave that strikes upon it.

The object of our invention, therefore, is the construction of a telephone in which the diaphragms can be rendered uniform in pitch and vibration, and so arranged in position that the sound-wave, in its impact upon the diaphragms, is magnified or intensified in the transmitting and receiving instruments, thereby producing a clear and distinct repetition of sounds from one instrument to the other.

The nature of our invention will be herein described fully, and then pointed out in the claims.

In the annexed drawings, the letter A represents a suitable box or casing, having attached thereto the diaphragms a a′, which are drawn into a concavo-convex shape by means of the buttons e e, drawn together by screw-tap f on the conducting-wire u. These diaphragms are firmly secured at their outer rim or edge to the framing p p′, said framing being held in place by ends r and sides s of the box. The box, diaphragms, and frames form an air-chamber, B, and are provided with segmental blocks q, inserted above and below, to overcome sharp angles of corners to render the sound more smooth.

The letter D represents a sound-collecting chamber, formed by the curved cover F and the diaphragm a, with its framing p, in which is inserted a mouth-piece, h, having a number of holes, j, in its surface, opening into the sound-

chamber, as shown, and through which air-vibrations are transmitted to the ear. The mouth piece h converges with a hole over the button e on the diaphragm. There are also communicating openings i i from air-chamber B into sound-collector chamber D, said openings being opened or closed by a circular valve or plate, x x, having counter-openings therein, as shown at k k k, Fig. 2, which are brought over the holes i i i at pleasure by moving the valve by the knob or projection, the valve turning on pins m m m m in slots l l l l.

The letter E represents an air-chamber formed by diaphragm a', and back of the box and sides s s r r.

The letters d d' represent corks or other insulating substances, through which the conducting-wire passes, and which serve to regulate the excessive vibration of the diaphragms and the twanging sound of the wire. The cork d' also closes the chamber E, rendering it a dead-air chamber, the same as B when the valves are closed.

The diaphragms are brought to the same degree of tension by the screw-top f, and being of the same size and texture and shape (concavo-convex) and on the same degree of tension, the vibration or impact of sound upon one is taken up by the other and transmitted by the conducting wire or cord to the other instrument.

In transmitting sounds the air-chamber B is closed, the air-chamber in the receiving-instrument being open, and vice versa. The air-chambers B and E both being closed when transmitting sounds and containing inert air, but subject to expansion and contraction by the impact of the sound-wave and alternation upon the diaphragms, the force [fol. 227] or intensity of the wave is increased or magnified to an extent that a whisper at one instrument is heard in a clear and audible whisper at the other, though a long distance may intervene between the two instruments connected by a wire or other conducting substance. The two telephones are brought in unison of vibration by using a straight conducting-wire between the same at a convenient distance and adjusting the diaphragms with the screw-tap until a clear and equal tone or wave length is received or given off by each.

The diaphragms are made of parchment, skin, or other suitable material, and have a vibrating surface seven or eight inches (more or less) in diameter each. Diaphragms,

however, can be made of metal, animal, or vegetable substances.

The conducting-line may be made of copper, steel, or galvanized-iron wire, or hemp or linen cord.

Having thus described our invention, what we claim as new, and desire to secure by Letters Patent, is—

1. In a telephone, the double concavo-convex-shaped diaphragm, of the same size, material, and texture and degree of tension, in combination with the conducting-wire, buttons, adjusting screw-tap, and insulating-cork, substantially as described.

2. In a telephone, the combination of the diaphragms, a a′ and framing p, with openings i, forming the front and rear walls of an air-chamber, substantially as set forth.

3. In a telephone, the combination, with the diaphragms a a′ and framing p, with openings i, of a valve-plate for opening or closing the openings in the framing p, substantially as and for the purpose set forth.

4. In a telephone, the combination of the chambers D, B, and E, formed by the casing A, diaphragms a a′, and curved cover F, substantially as shown and described.

5. In a telephone, the combination, with the curved cover F, diaphragm a, and transmitting-wire, of the mouth-piece h, with its inner open end registering over the button e of the transmitting-wire, and provided with a plurality of openings, j.

6. The combination, in a telephone, of the curved cover F, mouth-piece h, diaphragm a, perforated framing p, slid-in valve x, diaphragm a, casing A, and transmitting-wire, substantially as described.

In testimony whereof we affix our signatures in presence of two witnesses.

George K. Farrington, Homer C. Farrington.

Witnesses: Charles Still, Henry W. Eckert.

(Here follows drawing, side folio 228)

(No Model.)

W. B. HALE.

TELEPHONIC RECEIVING INSTRUMENT.

No. 254,642. Patented Mar. 7, 1882.

Fig. 1.

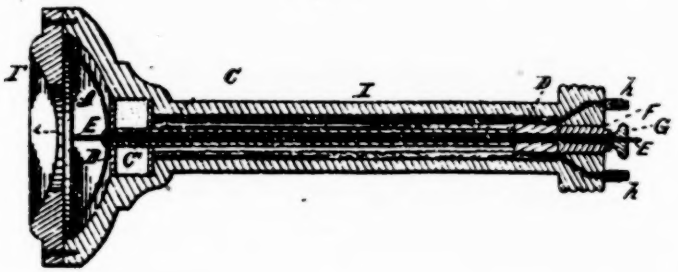
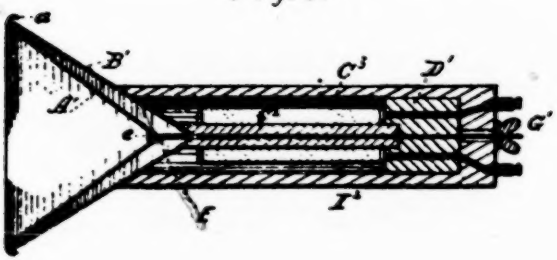


Fig. 2.



Witnesses
Phil. W. Hale
Charles E. Burdett

Inventor.
William B. Hale

[fol. 229] United States Patent Office

William B. Hale, of Washington, District of Columbia, Assignor to the United States Telephone Manufacturing Company, of New York, N. Y.

Telephonic Receiving-instrument

Specification Forming Part of Letters Patent No. 254,642, Dated March 7, 1882. Application filed July 26, 1881. (No model.)

To all whom it may concern:

Be it known that I William B. Hale, a citizen of the United States, residing at Washington, in the District of Columbia, having invented certain new and useful Improvements in Telephonic Receiving-Instruments; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to the letters or figures of reference marked thereon, which form a part of this specification.

This invention relates to a telephonic receiving-instrument in which the vibrations of a diaphragm are caused by the action thereupon of an iron or steel core, which lengthens and shortens under the influence of electric currents traversing a surrounding coil of wire.

A telephonic receiver of this class has heretofore been invented in which the core acts directly upon the center of a diaphragm which is confined at its periphery.

The object of my invention is to give a more effective vibration to the diaphragm, and to concentrate the air-vibrations produced thereby. This I accomplish by confining the diaphragm at a single central point only and exerting upon its outer margin the mechanical force which causes it to vibrate, this margin being left free to move in response to the action of the core.

In the accompanying drawings, Figure 1 is a central longitudinal section of a telephonic receiving-instrument constructed according to my invention, and Fig. 2 is a similar section of a modification thereof.

Referring to Fig. 1, the letter A indicates a diaphragm of any suitable material, either magnetic or non-magnetic—say, for instance, thin sheet metal, mica, hard rubber, or wood. The margin of this diaphragm rests freely against the edge of a cup, B, which has at its center an aperture, in which is screwed one end of a hollow or tubular core, C, of either iron or steel, which core has its other end abutted against a block of lead, D, which is bored centrally.

To the center of the diaphragm is secured one end of a non-magnetic rod, E, which extends through the tubular core C, the lead block D, and a washer, F, and has its other end screw-threaded to receive a thumb-nut, G, by which its strain upon the diaphragm may be regulated.

The letter C′ indicates a coil of wire surrounding a portion of the hollow core C, and having its terminals connected respectively with the binding-posts h, arranged at the end of the case I, in which the described parts are inclosed, said case having a front ear-piece, I′, with a central aperture, i, through which the air-vibrations pass outward from the diaphragm A.

It is known that when an electric current traverses a coil of wire which includes an iron or steel core the core expands, and resumes its normal position as the circuit is made or broken or the current is varied in strength. When, therefore, an electrical current is caused to traverse the coil C′, the core C elongates, driving the edge of the cup B against the margin of the diaphragm A, giving said diaphragm an outward half-vibration all around the central point which is confined by the rod E; and if the current ceases to flow, or its strength is decreased, the core C contracts wholly, or in proportion to the decrease in the strength of the current, drawing backward the cup B, allowing the diaphragm to resume or approach its normal position. When an electrical current is transmitted over the coil C′ by means of any suitable telephonic transmitting apparatus the lengthening and shortening of the core C, and consequently the vibrations of the diaphragm A, correspond to the variations of the current, the air vibrations or undulations emanating from the diaphragm producing sounds similar to those which cause the action of the transmitting apparatus.

It will be understood that when the current ceases in the coil or its strength becomes less, the core does not shorten to less than its normal length, but simply resumes or approaches that length, and therefore the diaphragm does not move rearwardly on its return vibration beyond its normal position. It therefore has no tendency toward an out- [fol. 230] wardly-convex form; but by the action of the edge of the cup upon its margin it is concaved rather toward a central line, this action tending to cause a convergence of the air-vibrations, resulting in the production of louder sounds than is the case where the center of the diaphragm is projected outward, giving the diaphragm a convexity tending to disperse the air vibrations or undulations.

The abutment D, I make of lead, because that metal is magnetically inert and non-vibratory, so that it is a perfect stop for the core C, the effective lengthening of which therefore takes place in the direction of the diaphragm.

In the modification illustrated in Fig. 3, the diaphragm is formed with an especial view to the condensing of the air vibrations or undulations toward a focus.

The letter A′ designates a hollow conical diaphragm having a flange, a, against which rests the base edge of a surrounding larger hollow cone, B′, having an opening in its apex in line with an opening in the apex of the center of the diaphragm A′.

The letter C^2 denotes the hollow core of an electro-magnet, of which C^3 is the coil. The core C^2 has one end bearing against the end of the cone B′, and the other end abutted against the end of a centrally-bored cylinder, D′, of lead, and preferably arranged in a socket or countersink in said cylinder.

A non-magnetic tension-rod, E′, (preferably of brass or other metal of considerable tensile strength, and not appreciably or but little affected by electric currents,) has a head, e, fitted snugly in the tip of the diaphragm A′, and extends through the same and through the opening of the cone B′, the hollow core C^2, and the bore of the lead cylinder D′, having a screw-threaded portion extending beyond said cylinder and through the end of the case I^2, outside of which it is provided with a thumb-nut, G′, and a suitable washer. The thumb-nut being screwed up to press its washer firmly against the case, the flange a is drawn against the edge of

the cone B^2, the tip of which is pressed against the adjacent end of the core C^2, the other end of which is drawn against the lead cylinder. The force with which the parts are thus pressed together is regulated by the thumb-nut, and should be such (as also in the form shown in Fig. 1) that none of the effect of the elongation of the core will be lost. When, now, electric currents of proper character are passed over the coil C^3, the core C^2 will be elongated and contracted in correspondence with said currents, driving the edge of the cone B′ against the flange a of the diaphragm, causing said diaphragm to vibrate and generate from its surface air vibrations or undulations, which converge toward a common focus, their united sound-producing effect being more intensified as the lines of vibration approach their ultimate point of convergence.

What I claim is—

1. In a telephonic receiving-instrument, the combination, with a diaphragm which is fixed at its center, but capable of vibrating at its perimeter and between its perimeter and center, of an electro-magnet having its core fixed at one end, and mechanical means for transmitting motion from the other end of said core to the margin of the diaphragm when said core is caused to expand by the influence of electric currents, substantially as described.

2. In a telephonic receiving-instrument, the combination, with a vibratory diaphragm having its center confined, of an electro-magnet having its core provided with an extension impinging against the margin of said diaphragm and arranged to cause the same to vibrate in response to the action of the core under the influence of electric currents traversing the coil of the magnet, substantially as described.

3. In a telephonic receiving-instrument, the combination, with the vibratory diaphragm, of an electro-magnet having a tubular core provided with an extension impinging against the margin of said diaphragm, a rod having one end secured to the center of said diaphragm and passing through the tubular core of the magnet, its other end being fixed, and a suitable stop for the end of the core opposite to that next the diaphragm.

4. The combination, with a suitably-supported concave diaphragm, of the tubular core of an electro-magnet ar-

(No Model.)

J. H. ROGERS.

TELEPHONE TRANSMITTER.

No 599,867 Patented Mar. 1, 1898.

Fig. 1.

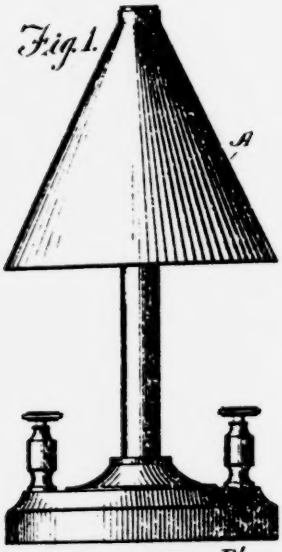


Fig. 2.

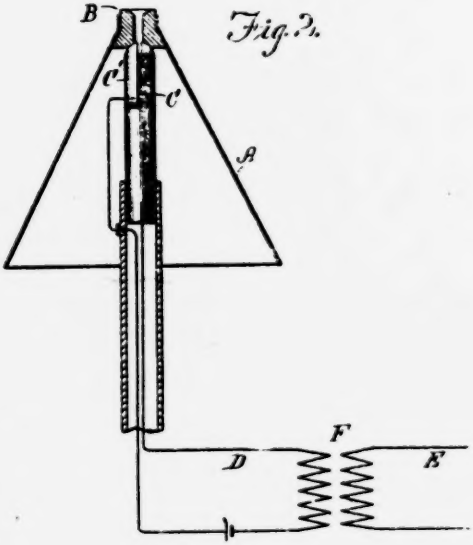


Fig. 3.

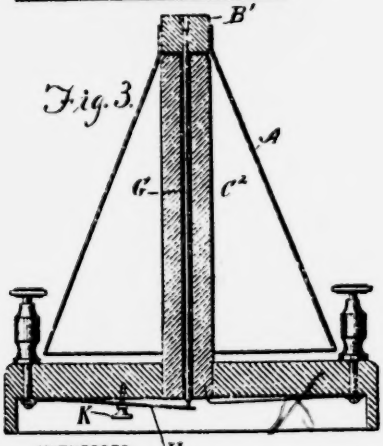


Fig. 4.

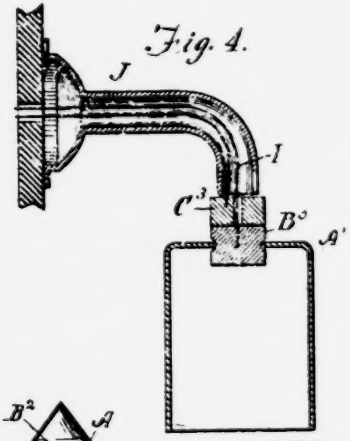


Fig. 5.

WITNESSES:

C. L. Belcher

H. H. Capel

INVENTOR

James H. Rogers

BY

A. L. Sommond

ATTORNEY

ranged to bear against said diaphragm, a rod extending from the apex of said diaphragm through the core of the magnet, and arranged to hold the center of the diaphragm in a fixed position with relation to the core, substantially as described.

5. The combination, with the vibratory diaphragm, of an electro-magnet having a tubular core, one end of which is provided with an extension bearing against the margin of said diaphragm, and the other end resting against a magnetically inert support, a rod secured to the center of said diaphragm and extending through the tubular core of the magnet, and arranged to hold the center of the diaphragm in a fixed position with relation to the core, substantially as described.

In testimony whereof I affix my signature in presence of two witnesses:

William B. Hale.

Witnesses: Wm. H. Bates, Charles E. Buell.

(Here follows drawing, side folio 231)

[fol. 232] United States Patent Office

James Harris Rogers, of Bladensburg, Maryland

Telephone-Transmitter

Specification forming part of Letters Patent No. 599,867, dated March 1, 1898. Application filed March 9, 1897. Serial No. 626,572. (No model.)

To all whom it may concern:

Be it known that I, James Harris Rogers, a citizen of the United States, and a resident of Bladensburg, in the county of Prince George's and State of Maryland, have invented a certain new and useful Telephone-Transmitter, of which the following is a specification.

This invention relates to telephone-transmitters, and particularly to electrical transmitters in which a variation in the extent of contract between the electrodes is depended upon for the transmission of electrical impulses or undula-

tions corresponding to the vibrations of undulations of the air caused by vocal or other sounds.

The object of this invention is the production of a reliable, convenient, and inexpensive transmitter; and to this end the invention consists in the construction, combination, and arrangement of parts hereinafter fully described and set forth in the claims.

In the accompanying drawings, which form a part of this specification, Figure 1 represents in side elevation one form of the improved transmitter. Fig. 2 represents in vertical section the effective parts of the transmitter and also shows diagrammatically its connection in circuit. Fig. 3 shows a modification of that form of transmitter adapted for use upon a table or desk. Fig. 4 represents a modification in the transmitter and shows it attached to a wall-bracket. Fig. 5 represents a modification in the construction of the electrodes.

In transmitters heretofore constructed diaphragms or membranes for receiving the impact of sound-waves have been connected to movable electrodes, but have been confined in one way or another within casings of various sorts and have been generally of very limited area. They have also generally been associated with a tube or mouthpiece for directing the sound-waves thereagainst. In the present invention that upon which the sound-waves impinge or against which they are directed is entirely exposed and free to vibrate in response to the impinging waves whatever their form, source, or velocity. In so far as this part receives the sound-waves it resembles the diaphragm or membrane of the ordinary transmitter, but its construction, operation, and effectiveness being materially different from the ordinary diaphragm it has been deemed advisable to give to it the name of "target" or "sounding-board."

In the drawings, A indicates this sounding-board or target, which is connected to a movable part or member of the electrodes of the transmitter, and consists of some light elastic material, such as celluloid. Said movable part or member of the electrodes may be made in various forms and adapted to cooperate with the fixed or otherwise supported electrode or electrodes in various ways, four different forms therefor being indicated in the drawings at B B′ B^2 B^3.

In Fig. 2 the part B of the electrodes acts to span the portions C and C′ of the fixed electrode, these portions being insulated from one another, as indicated, and connected in the local circuit B, which, as usual, has communication with the line E through the inductorium F.

In Fig. 3 the part B′ is indicated as resting directly upon the flat end of the fixed electrode C^2, the part B′ serving in this instance as one of the electrodes and being connected to the circuit of the transmitter by means of the insulated conductor G, which in this form of the instrument is passed through the fixed electrode and engages at its lower end with a spring H, electrically connected to one of the binding-posts of the instrument, the electrode C^2 being connected to the other binding-post, as indicated. The conductor G also serves as a projection from B′ into C^2 for holding the former in place upon the latter.

In Fig. 4 the part B^3 is shown suspended by the conductor I from the lower end of the wall-bracket J. Resting upon this or secured to the bracket I and engaging with the electrode B^3 is the cooperating electrode C^3, from which the other terminal of the transmitter-circuit leads through the bracket J.

In Fig. 5 the electrode B^4 has its lower end made in speroidal form and is placed or supported as a projection from B^4 in a cup in the upper end of the fixed electrode C^4. The target A is secured to the electrode B^4 in any suitable manner and the circuit-terminals of the transmitter are connected in any suitable way to the electrodes B^2 and C^4.

The target or sounding-board is by preference made of some thin light material which is not detrimentally affected [fol. 233] in any way by moisture. Celluloid has been used for this purpose, but other similar light elastic substances will do as well. The target or sounding-board may be of any suitable shape and secured to the movable member of the electrodes in any suitable manner, but in practice a conical or skirt-like form, such as illustrated, has been found preferable. It is also preferable to attach this conical sounding-board by its apex to the movable electrode and to have it depend therefrom. It might, however, in the construction of apparatus shown in Fig. 3, be inverted, so

that the base of the cone would be uppermost. It is believed that the conical form is most efficient because of its not having any particular tone of its own, but being capable because of its graded diameters to respond to any and all tones.

If it is desired simply to obtain an extended area for the sounding-board regardless of its inherent tone, it may assume a cylindrical form, as indicated in Fig. 4.

If the sounding-board is made of considerable size, and it may be made of any desired size, the construction represented in Fig. 3 is perhaps the best, since therein a portion of the weight of the electrode B and the sounding-board may be sustained by the spring H. Any suitable tension device, such as indicated at K, may be added to this spring to vary the degree of pressure between the electrodes B' and C'.

The electrodes may also be made of any suitable material, but they are preferably made of carbon.

What I claim as my invention is—

1. In a telephone-transmitter, the combination with a suitable support, of a fixed electrode projecting therefrom, a movable electrode mounted upon the fixed electrode, and a sounding-board of light elastic material, such as celluloid, attached to and depending from the movable electrode in a conical or skirt-like form so as to produce an extended surface adapted to receive sound-waves from all sides and to convey the motion produced thereby to the movable electrode, as and for the purpose set forth.

2. In a telephone-transmitter, the combination with a fixed electrode, of a movable electrode mounted thereon and having a projection entering the fixed electrode to hold it in place on the latter, and an elastic conical or skirt-like sounding-board or target depending from the movable electrode for the purpose set forth.

3. In a telephone-transmitter, the combination with a fixed electrode of a movable electrode mounted thereon, a sounding-board or target attached to the latter, an insulated conductor extending from the movable electrode through the fixed electrode, and a spring forming one terminal of the circuit through the transmitter and serving as a partial support for said conductor, the movable electrode and the sounding-board or target.

No. 654,360. Patented July 24, 1900.

E. SCHOPF.

SOUNDING BOARD SUPPORT.

(Application filed Feb. 19, 1900.)

(No Model.)

FIG. I.

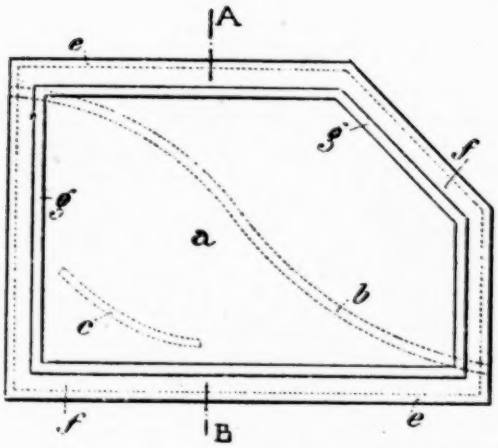
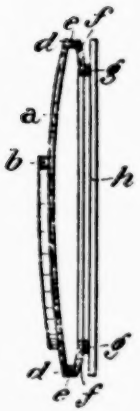


FIG. I.



Witnesses:

Inventor:

Emil Schopf.

Signed at Washington, in the District of Columbia, this 1st day of March, A. D. 1897.

James Harris Rogers.

Witnesses: Joseph L. Rogers, James C. Rogers.

(Here follows drawing, side folio 234)

[fol. 235] United States Patent Office

Emil Schopf, of Berlin, Germany

Sounding-Board Support

Specification forming part of Letters Patent No. 654,360, dated July 24, 1900. Application filed February 12, 1900. Serial No. 4,934. (No model.)

To all whom it may concern:

Be it known that I, Emil Schopf, pianoforte manufacturer, a subject of the German Emperor, residing at Markusstrasse 18, Berlin, Germany, have invented certain new and useful Improvements in Sounding-Board Supports, of which the following is a specification.

Sounding-boards for musical instruments as generally used rest around their rim on a frame wherewith they are firmly connected. By this firm connection of the sounding-board with a stationary frame the sounding-board around about the edges up to a pretty considerable distance cannot vibrate and only the middle part of the sounding-board is able to make vibrations of an amplitude necessary to obtain a perfect sound. This disadvantage is especially perceptible in the shorter treble-strings of an upright piano or horizontal piano, which lie near to that part of the sounding-board which is close to the supporting-frame. The sound of these strings is not reinforced by the vibrations of the sounding-board in comparison with that of the middle strings, so that the difference between the beauty of the sound of the upper octave of a piano and the middle octaves is thus explicable. In order to do away with these disadvantages, the absolutely stationary fixing of the rim of the sounding-board is avoided in the present construction, so that the whole sounding-board can freely vibrate.

Figure 1 of the annexed drawings is an under plan view of the sounding-board shown separate from its seat, the seat being omitted in order to make the drawing clearer. Fig. II is a section of the line A B, Fig. 1, showing also the seat.

The real sounding-board a, which can be made of usual sounding-board wood, receives its tension by the two bridges b and c.

To enable the sounding-board to vibrate to the border, the outermost border d of the sounding-board is provided with an edging-fillet e, extending around its circumference and firmly connected on the one side with the sounding-board and on the other side with a wooden plank f, also extending around the circumference of the sounding-board. This wooden plank f is again provided along the edge opposite that by which it is attached to the sounding-board proper with a resting-fillet g, fastened on the support h, by which it is fastened in the instrument. The wooden plank f is made of hard wood, while for the sounding-board proper soft wood is used, as is well-known. The reason is the same as in violins—that is, to enable the sound-waves to rebound on this part f, so that only the real sounding-board a comes into vibratory effect. In this manner the sounding-board is able to swing like a spring or similar cross-section—that is, the sounding-board is able to swing also at its edges because direct fastening of the edges is avoided by the use of the intermediate support, consisting of the plank f.

I declare that what I claim is—

The combination with a sounding-board a of a fillet e having one of its faces glued to the under face of the sounding-board at its edge, a hard-wood plank frame f having the same shape exteriorly as the sounding-board glued at the outer edge of one of its faces to the under face of said fillet e and a fillet g glued to the under face of said plank frame f at the inner edge thereof.

In witness whereof I have signed this specification in the presence of two witnesses.

Emil Schopf.

Witnesses: Woldemar Haupt, Henry Hasper.

(Here follow drawings, side folios 236, 237, 238, and 239)

No. 674,575. Patented May 21, 1901.

A. L. DUWELIUS.

PHONOGRAPH.

(Application filed June 20, 1900.)

(No Model.) 4 Sheets—Sheet 1.

Fig. 1.

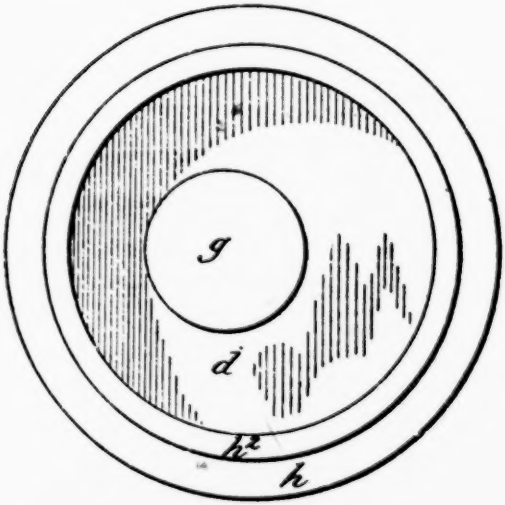
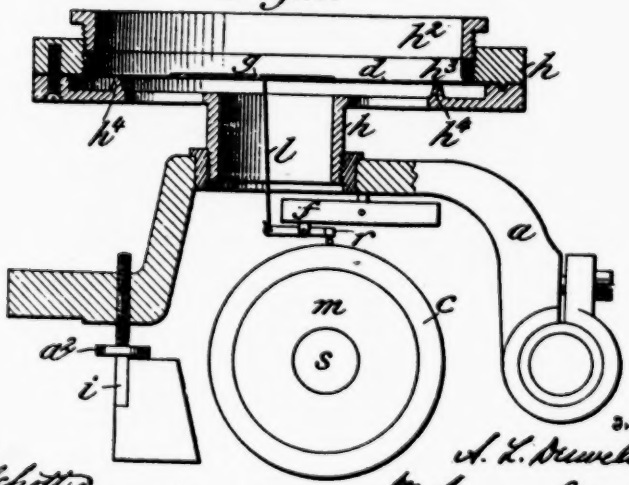


Fig. 2.



Witnesses

F. H. Schott

J. E. Hutchinson Jr.

Inventor

A. L. Duwelius,

by Munn & Goldsborough

Attorneys.

No. 674,575. Patented May 21, 1901.

A. L. DUWELIUS.

PHONOGRAPH.

(No Model.) (Application filed June 20, 1898.) 4 Sheets—Sheet 2.

Fig. 5.

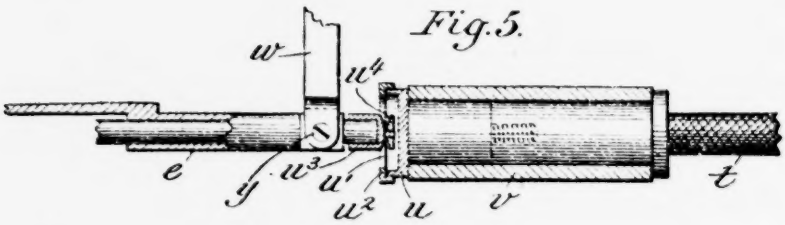


Fig. 3.

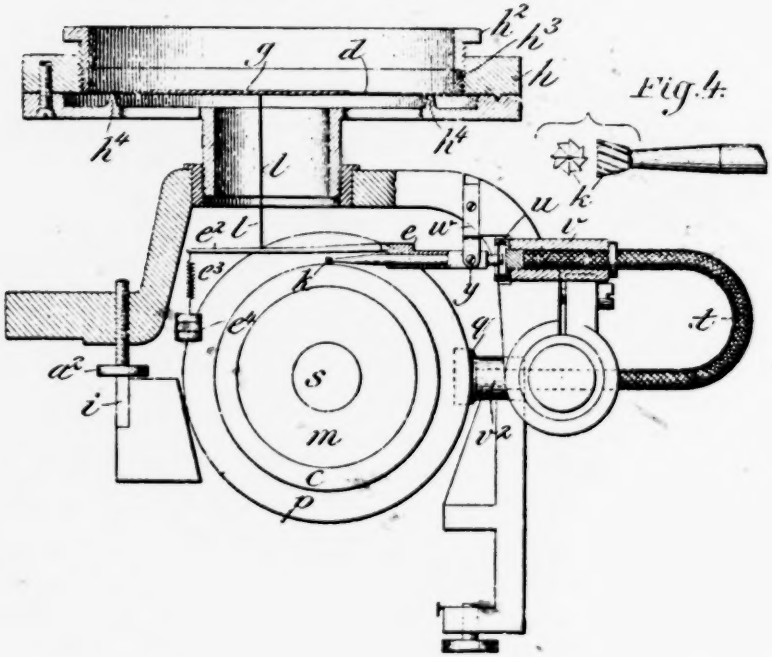


Fig. 4.

Witnesses:
D. W. Edelin.
J. E. Hutchinson Jr.

Inventor:
A. L. Duwelius,
by Connie & Goldsmith,
Attys.

No. 674,575. Patented May 21, 1901.

A. L. DUWELIUS.

PHONOGRAPH.

(Application filed June 20, 1896.)

(No Model.) 4 Sheets—Sheet 3.

Fig. 7.

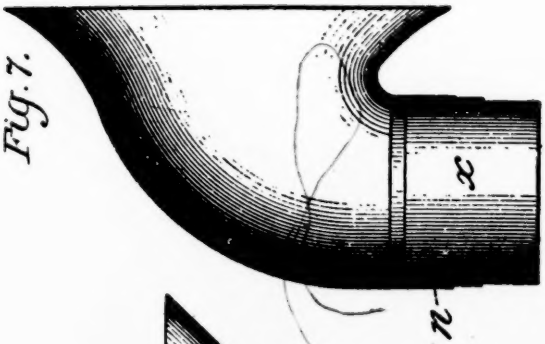
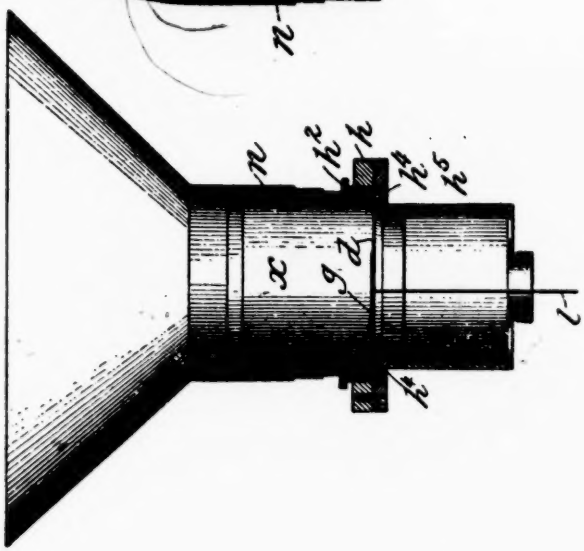


Fig. 6.



Witnesses:
D. W. Edelin.
J. E. Hutchinson Jr.

Inventor:
A. L. Duwelius,
by Lemmie & Goldsborough,
Attys

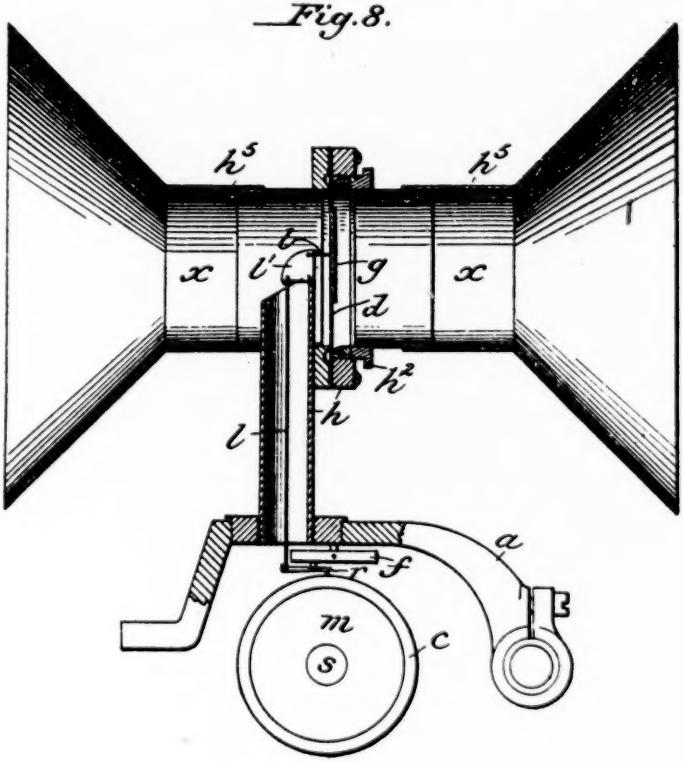
No. 674,575. Patented May 21, 1901.

A. L. DUWELIUS.

PHONOGRAPH.

(No Model.) (Application filed June 20, 1900.) 4 Sheets—Sheet 4.

Fig. 8.



Witnesses
H. H. Schott
J. L. Hutchinson Jr.

Inventor
A. L. Duwelius,
by Lemuel W. Serrell
Attorney.

[fol. 240] United States Patent Office

Augustus L. Duwelius, of Cincinnati, Ohio, Assignor to Alfred H. Duwelius and Walter S. Duwelius, of Same Place

Phonograph

Specification forming part of Letters Patent No. 674,575, dated May 21, 1901. Application filed June 20, 1898. Serial No. 683,979. (No model.)

To all whom it may concern:

Be it known that I, Augustus L. Duwelius, a citizen of the United States, residing at Cincinnati, county of Hamilton, State of Ohio, have invented certain new and useful Improvements in the Art of Reproducing Sound; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to certain new and useful improvements in the art of reproducing sound; and it has for its object to provide means for obtaining a more nearly perfect reproduction of sound than has been heretofore attainable. I use the term "reproduction" in its general sense as including the entire operation of reproduction from the initial step of receiving and recording the sound to the final step of receiving and rendering it again audible.

It is well known that the loudness of sound produced by a vibrating diaphragm is dependent upon the amplitude of vibration of the diaphragm. Heretofore in the construction of sound-reproducing devices the practice has been in accordance with this law of physics to increase or diminish the amplitude of vibration of the receiving-diaphragm according as it was desired to increase or diminish the volume of the reproduced sound. I have discovered, however, that in dealing with complex sounds of varying volume, quality of tone or timbre, and distinctness of articulation—such, for instance, as the articulations of the human voice—better results are obtained by providing a diaphragm having a total mean effective area of not less than three and a half square inches. It has also been the general practice in the

construction of the speaking-trumpets employed as sound-ducts between the diaphragm and the atmosphere to give them substantially the form of a cone terminating at its smaller end in a neck provided with a throat much smaller in area than the area of the diaphragm. I have found that much better results are obtained by providing a throat having an area of not less than nine-sixteenths of the area of the vibrating portion of the diaphragm, and also that when the throat is so constructed as to admit of a variation of its length pleasing effects may be produced, sometimes to the extent of materially improving the reproduction of badly-recorded sound. I have further discovered that by providing a tubular extension to the reverse side of the diaphragm-holder the sonorousness of the apparatus may be still further increased. This circumstance I attribute to the fact that the tubular extension contains a relatively deep column of air, confined at the sides but, establishing practically unobstructed communication between the diaphragm and the external air at the end of the tubular extension, that it acts as a resonator varying the sharpness or hollowness of the tone, and that it serves, in combination with the tubular extension or throat on the obverse side of the diaphragm, to establish sonorous zones or sound-waves remote from the apparatus by causing positive vibrations synchronous with the reciprocating movements of both sides of the diaphragm, and producing thereby positive alternate compressions and rarefactions of the atmosphere in contact with the tympanum of the ear. I have further discovered that by placing the diaphragm in a vertical position a more perfect reproduction of sound is obtained.

Another feature of my invention relates particularly to the recording step in the general operation of sound reproduction. Heretofore it has been customary to record the sound-vibrations upon a revolving cylinder or disk of wax or like material having a soft surface, through the agency of a gouge actuated by the diaphragm to produce i-dentations of varying depth corresponding to the diaphragm vibrations. Owing to the nature of the material employed in their construction, these record cylinders or disks are quite fragile, and the engraved records upon their surfaces are easily ruined by careless handling and have a comparatively short-lived usefulness under the best conditions. The softness of the material soon permits the sharpness of

the indentations to become blunted, in consequence of which much detail is lost in the reproduction of the sound. I have devised a method through the agency of which rec- [fol. 241] ords of sound-waves may be engraved upon the surface of harder materials, such as metals, and their durability and consequent clearness greatly enhanced. This feature of my invention consists, generally speaking, in the employment of a revolving cutter or abrader guided and controlled by the vibrating diaphragm, so that the diaphragm instead of supplying the power necessary to engrave merely regulates the depth of the cut.

My invention is applicable generally to sound-reproducing devices, and particularly to the phonograph, graphophone, gramophone, and the like, as will be readily understood.

In the accompanying drawings, Figure 1 represents a plan view of my improved diaphragm and holder. Fig. 2 represents a sectional view of the diaphragm and holder and their adjuncts partly in elevation. Fig. 3 represents an end view, partly in section, of a phonograph equipped with my improved diaphragm and holder and record-engraving device. Fig. 4 represents, on a larger scale, one form of my revolving cutter-tool. Fig. 5 represents, in section and on a larger scale, the preferred means for connecting the shank of the revolving cutter with the flexible driving-shaft. Fig. 6 represents a central sectional view of my improved diaphragm and holder, the tubular extension, and the adjustable sound-duct. Fig. 7 represents a modified form of the sound-duct. Fig. 8 represents a form of my apparatus in which the diaphragm d and its holder h are employed in a vertical position, the connection with the links l being made through a bell-crank or angle lever l', fulcrumed on the holder h. In the form shown sound-ducts with tubular throats x x are applied to both sides of the diaphragm-holder.

Similar letters of reference indicate similar parts throughout the several views.

Referring to the drawings, and particularly to Figs. 1 and 2 thereof, s indicates the rotatory shaft of the phonograph, driven from any suitable source of power and provided with the customary mandrel m. c indicates the record-cylinder; r, the reproducing-stylus and fulcrumed car-

rier; f, the floating fulcrum and weight; a, the speaker-arm support; a^2, the adjusting-screws, and I the rail upon which the adjusting screws are adapted to ride. All of these parts being well known in the art, their construction and mode of operation will be readily understood.

Attached to the speaker arm or support a is shown my diaphragm-holder h, clamping the rim of the diaphragm d, the tension of which is regulated by the screw h^2 and washer h^3, together with the circular bridge h^4. On the face of the diaphragm d, but eccentric thereto, is shown the relatively non-flexible area g, connected with the stylus-carrier r by the link l. This non-flexible area may be produced by adding a stiff disk to either side of the diaphragm, as shown, or may be produced by corrugating or embossing the diaphragm itself or by scoring it, or in many other ways and forms. The ratio of the non-flexible to the flexible area of the diaphragm will depend upon the nature of the materials employed, but should be as great as permissible in order to produce vibration over the largest area possible.

By locating the non-flexible area in a position eccentric to the main portion of the diaphragm the practical effect is to impart a different kind of movement thereto and to produce better results. Thus when so located the resistance to its movement becomes unequal and that portion of its periphery and surface nearest the edge or rim of the diaphragm offers the greatest resistance to motion and becomes relatively to a greater or less extent (depending upon the degree of eccentricity) a fulcrum. In other words, the non-flexible area becomes in effect a musical reed.

As shown in Fig. 6, the diaphragm-holder is preferably provided at the reverse side of the diaphragm with a tubular extension h^5, serving as a resonator and containing a comparatively deep column of air in communication with the external atmosphere and confined at its sides. The sound-duct is provided with a throat x, preferably of approximately the same size as the diaphragm, but which should in any event not be less in area than nine-sixteenths of the vibrating portion of the diaphragm. In order to vary the effect, the neck n of the sound-duct is made adjustable in length, preferably by constructing it of a number of sections telescoping within one another. I have found by experiment that for most sounds a length of tube or

throat approximately equal to its diameter is most desirable. In the form shown in Fig. 6 the sound-duct is adapted to project the sound vertically, while in the form shown in Fig. 7 it is intended to project the sound horizontally.

The means for obtaining the permanent record constituting a feature of my invention are illustrated in Fig. 3, one of the forms of cutting-tool or abrader being shown in Figs. 4 and 5. The cutting-tool k, which is designed to revolve rapidly, is journaled in a carrier e and is driven by a shaft s through the instrumentality of the friction-gears p q, the flexible shaft t, and the coupling u. The ends of the flexible shaft t are journaled in bearings v v^2. The form of flexible coupling u shown consists of a flexible diaphragm u', having its rim clamped in a recessed case u^2, which is joined to and driven by the flexible shaft t. Attached to the center of this diaphragm by means of the nut u^4 is the tool-socket u^3, through which the necessary engagement with the shank of the cutting-tool is made. The cutting-tool carrier e is trunnioned and is carried in the forked support w through the agency of the pointed screws [fol. 242] y, which permit it to move freely in a vertical direction, but prevent all horizontal movement. The tool-carrier e is provided with the extended arm e^2, which through the link l makes connection with the diaphragm by which the vertical movement of the cutting-tool is controlled.

At the extreme end of the arm e^2 is shown connected therewith a spiral spring e^3, carrying a suspended weight e^4. The purpose of this combination of weight and spring is to furnish the necessary pressure to the cutting-tool responsively to the variations of the diaphragm d and to avoid "chattering." The maximum depth of cutting may be regulated by the screws a^2. The angle of cutting may be altered, as required, by slightly withdrawing the bearing v and lowering the tool by means of the screw a^2. The operation of the device is such that the rotation of the cylinder e against the rapidly-revolving cutter k causes the surface of the cylinder to be scored to such depths as the variations of the diaphragm d, actuated by the impinging sound-waves, may permit.

Having thus described my said invention, what I claim is—

1. In a sound-reproducing apparatus, a vibratory diaphragm having a substantially non-flexible area eccentric thereto.

2. In a sound-reproducing apparatus, the combination with a vibratory diaphragm having a non-flexible area eccentric thereto, of a sound-duct having an adjustable throat leading to said diaphragm.

3. In a sound-recording apparatus, the combination with a record-surface, a cutting or abrading tool rotatable on an axis substantially parallel to the direction of movement of said surface at the point of engagement with said tool, of means for rotating the same, and a diaphragm for vibrating and governing the depth of cut of the tool in accordance with the diaphragm vibrations.

4. In a sound-reproducing apparatus, the combination with a cutting or abrading tool, of means for rotating it, a vibratory diaphragm having a portion of inferior flexibility connected to said cutting or abrading tool to govern the depth of cut thereof.

5. In a sound-reproducing apparatus, the combination of a vibratory diaphragm having an area of inferior flexibility eccentric to the diaphragm as a whole, and an air-column chamber on the reverse side of said diaphragm.

In testimony whereof I affix my signature in presence of two witnesses.

Augustus L. Duwelius.

Witnesses: Leonard W. Goss, Arch. Mirrielees.

(Here follow drawings, side folios 243 and 244)

[fol. 245] United States Patent Office

Frank F. Shanks, of Chicago, Illinois

Phonograph, Gramophone, and Other Similar Sound-reproducing Machines

Specification of Letters Patent

No. 822,024. Patented May 29, 1906

Application Filed February 20, 1905. Serial No. 246,612

To all whom it may concern:

Be it known that I, Frank F. Shanks, a citizen of the United States, and a resident of Chicago, in the county of

No. 822,024. PATENTED MAY 29, 1906.

F. F. SHANKS.

PHONOGRAPH, GRAMOPHONE, AND OTHER SIMILAR SOUND REPRODUCING MACHINES.

APPLICATION FILED FEB. 20, 1905. 2 SHEETS—SHEET 1

Fig. 1.

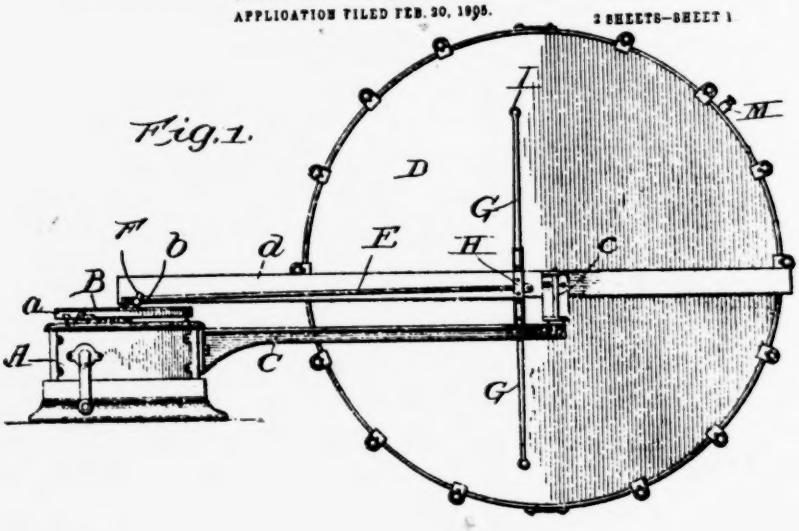
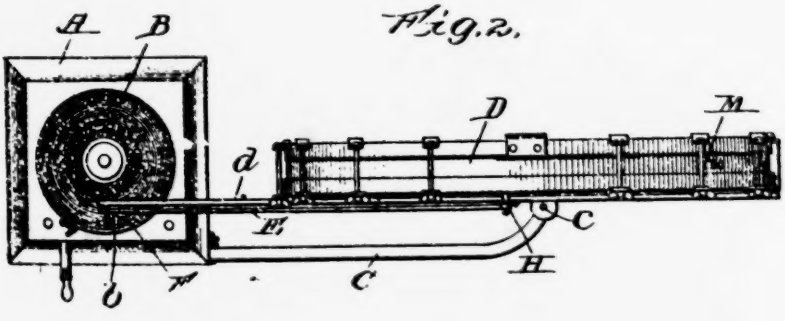


Fig. 2.



Witnesses:
C. M. Hemrich
C. K. Lundy

Inventor:
Frank F. Shanks
by Frank D. Thomason
Atty.

No. 822,024 PATENTED MAY 29, 1906.

F. F. SHANKS.

PHONOGRAPH, GRAMOPHONE, AND OTHER SIMILAR SOUND REPRODUCING MACHINES.

APPLICATION FILED FEB. 20, 1905.

2 SHEETS—SHEET 2

Fig. 3.

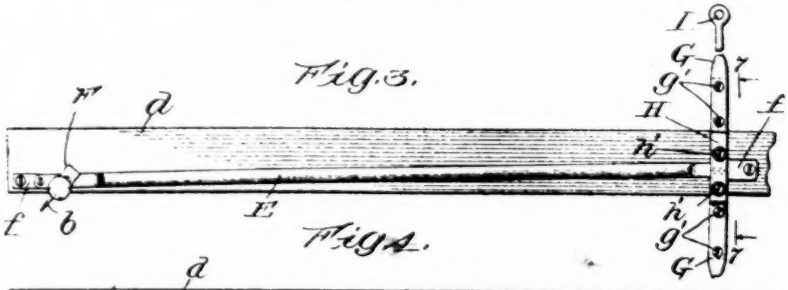


Fig. 4.

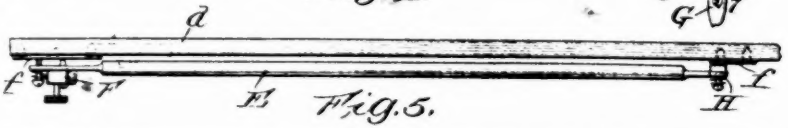


Fig. 5.

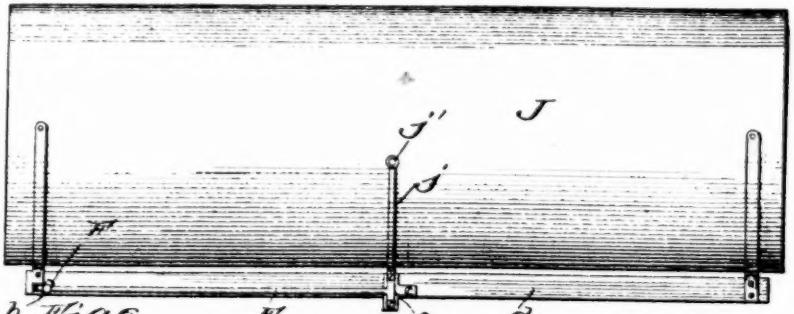


Fig. 6.

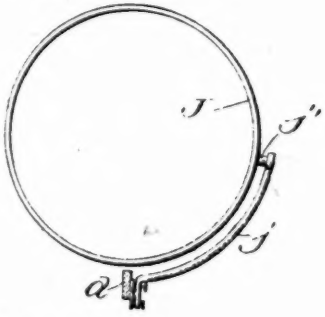
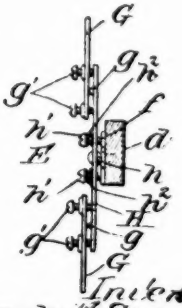


Fig. 7.



Witnesses:
Chas. Hemick
E. K. Lundy

Inventor:
Frank F. Shanks
By Frank D. Thompson
Atty.

Cook and State of Illinois, have invented certain new and useful Improvements in Phonographs, Gramophones, and other Similar Sound-Reproducing Machines, of which the following is a full, clear, and exact description.

My invention relates to machines for reproducing sounds from records in what are commonly known as "phonographs," "gramophones," &c.; and its particular object is to provide means whereby sound-waves energized by the instrument are transmitted therefrom and audibly delivered at a distance from the needle or tracker engaging the record to the hearer in clear ringing tones.

Heretofore it has generally been found very difficult and well-nigh impossible to reproduce sounds from the machine in the precise manner and tone in which they were originally received by the record. This was often caused by the vibrations of the sound-waves passing through the metal horn or megaphone, and therefore the sound reproduced was "metallic" in tone and high notes or swells became harsh and rasping. These objectionable features have all been overcome by my improved means for the transmission to a point beyond the range of the immediate vibratory field of the needle or tracker and the audible delivery of the transmitted sound-waves after they have been projected upon a reproducing device. I accomplish this by the mechanism hereinafter fully described in the specification and illustrated in the drawings and as more fully pointed out in the claims.

In the drawings, Figure 1 is a side elevation of one form of my improved device, showing the same in connection with a snare-drum and operating with a phonograph of the disk type. Fig. 2 is a top plan view of the same. Fig. 3 is a front elevation in detail of the sound-wave-transmission portion of my improvement. Fig. 4 is a top plan view of the same. Figs. 5 and 6 are front elevation and end views of a modified form of resonator used in connection with my improvement. Fig. 7 is a transverse vertical section taken on line 7 7, Fig. 3, looking in the direction indicated by the arrows and showing the manner of connecting and adjusting the vibrating arms.

For the purpose of a clear understanding of my invention I have illustrated the same operating in connection with a phonograph of the disk type; but it will be obvious to

those skilled in the art to which this invention appertains that the same is applicable to any of the sound-reproducing or talking machines now in general use.

By referring to the drawings it will be seen that A represents the box or casing in which is housed the proper mechanism for revolving the flat circular platform a or the table thereof, which latter carries the usual record-disk B, from which the sound-waves are reproduced through the medium of a steel reproducer needle-point b. Extending horizontally from one side of the casing A is an elongated L-shaped supporting-arm C, that has arising from its outer extremity a suitable pivot stud or pin c, the upper portion of which latter is reduced slightly in diameter to provide a shoulder, as will be seen in Fig. 1 of the drawings. Upon the end of this arm C are supported my improved sound magnifying or intonating means, which, as well be hereinafter more fully described, may consist of a drum-shaped disk or resonator, a hollow elongated cylinder, a banjo, violin, or other stringed musical instrument from which the sound-waves are vibrated or deflected in a greater or increased volume than received. For the sake of convenience I will describe the same in connection with the drum-shaped resonator D illustrated in Figs. 1 and 2 of the drawings. The resonator D is preferably constructed similar to an ordinary snare-drum, except that in place of the usual sheepskin or parchment covering it is provided with a covering of cloth coated with a fibrous composition or paper and its dimensions are approximately twenty-four inches in diameter by one and one-half inches in thickness. These dimensions are not essential, however, and while I prefer to use the covering above described the usual sheepskin covering may be employed without departing from the principle of my invention. Bridging across the face of the resonator D, but not in contact with the surface thereof, is a straight shaft d, that projects beyond the edge of the resonator nearest the phonograph until its end is over the center of the record-disk. This shaft is used as a support for the resonator D, as well as to carry the means for holding the sound-vibrat- [fol. 246] ing devices and vibrators now to be described. These sound-vibrating devices comprise an elongated rock-bar E, extending from near the outer end of the shaft d to about the center of the resonator D, and the same is sup-

ported away from said shaft d by fulcrum-pivots x and is adjustable toward and away from said shaft by set-screws at either end of the same engaging with a screw-plate f, mounted upon the contiguous portion of the shaft. On the outer end of this rock-bar E is mounted at a tangent angle thereto the needle-carrying block F, which is preferably secured thereto by means of a suitable adjusting-screw. The needle-point b is adjustably held in said block F by means of a small thumb-screw in order to readily remove and replace the same whenever so desired. This bar E is rocked by the engagement of the needle-stylus b with the record-disk, and said rocking motion of the bar imparts a vibratory movement to arm G, hereinafter referred to. At the end of the rock-bar E opposite said needle is fastened a suitable transverse plate H, that is provided mediate its extremities with a fulcrum-pivot h, and in order to adjust either end of said plate suitable adjusting screws h′ are provided, one on each side of said pivot, while between the heads of said screws and said plate are interposed suitable coil-springs h^2. Near each end of said plate H are suitable fulcrum-pivots g, that form ribs extending across the width of the plate, and upon which is fulcrumed the contiguous flattened end of said vibrator-arm G. These vibrator-arms G are adjustable toward and away from the surface of the resonator by suitable set-screws g′. Upon the ends of each of these vibrator-arms G are mounted suitable hammers I, the surfaces of which are preferably formed of or covered with rubber or other suitable material. These hammers are adapted to be rapidly vibrated against the face of the diaphragm or resonator D and to impart thereto the bodily-vibratory movements transmitted to said hammers through the rock-bar E, said vibrations being in direct accord with the sound undulations on the record-disk.

When the machine is in operation, the sound-waves are imparted by the revolving disk B to the needle-point, and the vibrations thus created are conveyed along rod E and transmitted therefrom to the vibrating arms G. These arms G are caused to rapidly vibrate and the hammers I on their ends throw off the vibrations against the adjacent face of the resonator F, which latter reproduces the sound-waves and intensifies the same in clear full tones.

While it is not absolutely essential, I may construct the drum-shaped resonator airtight and provide an outward pressure-valve M in the edge thereof. By forcing air between the heads of the drum or resonator the tension of the face thereof may be adjusted to a nicety and a purer tone obtained thereby.

In the modification shown in Figs. 5 and 6 in place of the drum-shaped resonator described heretofore I employ a hollow elongated cylinder J, made of any suitable resounding material that is preferably stretched over a suitable framework and formed air-tight. In this modification the supporting shaft d and rock-bar E, as well as the reproducing-needle b and the means for adjusting said bar E, are all similar in construction to the corresponding elements described in connection with resonator D. The vibrating arm, however, is of a segmental character, and its curvature corresponds with the curvature of the outer circumference of said cylinder and extends around the same about one-quarter of the circumference thereof. A hammer j′ is also provided, which, if desired, may be similar to the hammer I.

When different kinds of musical selections are to be reproduced by the phonograph, I have found it very advisable to employ different kinds and sizes of resonators. When the record contains a violin solo, it has been found that by substituting a violin in place of the "drum," hereinbefore described, and permitting the vibrating arm, which may be covered with rubber, to pass over all the strings thereof, that the sound-waves and tone of reproduction are decidedly more natural and the music is not harsh or rough, as is now the case with phonographs employing a horn or megaphone. By substituting the proper instrument for one similar to the instrument used in making the record much better results have been attained. It has been found also that an orchestral or band selection is better reproduced by mounting an entirely metallic cylinder similar to that shown in Figs. 5 and 6 upon the supporting shaft, and when it is desired to reproduce the human voice it has been found that the drum hereinbefore described is the most satisfactory.

What I claim as new is—

1. In combination, a phonographic record; devices engaging the sound-interlineations thereon; a solid bar for transmitting the vibrations resulting from said engage-

ment to a point beyond the range of the cynchronous sympathetic vibrations of said devices; and disconnected means for audibly reproducing said vibrations at the opposite end of said bar.

2. In combination, a phonographic record; devices engaging the sound-interlineations thereon; a solid bar directly engaging said devices which transmit the vibrations resulting from said engagement to a point beyond the range of the synchronous sympathetic vibrations of said devices; and disconnected means for audibly reproducing said vibrations at the opposite end of said bar.

[fol. 247] 3. In combination, a phonographic record; a needle engaging the sound-interlineations thereon; a rod for transmitting the vibrations resulting from said engagement to a point beyond the range of the synchronous sympathetic vibrations of said needle; a vibratory arm carrier by said rod; and means for reproducing said vibrations at the end of said rod nearest said vibratory arm.

4. In combination, a phonographic record; a needle engaging the sound-interlineations thereon; a fulcrumed rod for transmitting the vibrations resulting from said engagement to a point beyond the range of the synchronous sympathetic vibrations of said needle; a vibratory arm carried by said rod; and means for reproducing said vibrations at the end of said rod nearest said vibratory arm.

5. In combination, a phonographic record; a needle engaging the sound-interlineations thereon; a yieldingly-fulcrumed rod for transmitting the vibrations resulting from said engagement to a point beyond the range of the synchronous sympathetic vibrations of said needle; a vibratory arm carried by said rod; and means for reproducing said vibrations at the end of said rod nearest said vibratory arm.

6. In combination, a phonographic record; a needle engaging the sound-interlineations thereon; a rod for transmitting the vibrations resulting from said engagement to a point beyond the range of the synchronous sympathetic vibrations of said needle; an adjustable vibratory arm carried by said rod; and means for reproducing said vibrations at the end of said rod nearest said vibratory arm.

7. In combination, a phonographic record; a needle engaging the sound-interlineations thereon; a rod for transmitting the vibrations resulting from said engagement to a point beyond the range of the synchronous sympathetic

vibrations of said needle; an adjustable fulcrumed arm carried by said rod; and means for reproducing said vibrations at the end of said rod nearest said vibratory arm.

8. In combination, a phonographic record; a needle engaging the sound-interlineations thereon, a yieldingly-fulcrumed rod for transmitting the vibrations resulting from said engagement to a point beyond the range of the synchronous sympathetic vibrations of said needle; an adjustable fulcrumed vibratory arm carried by said rod; and means for reproducing said vibrations at the end of said rod nearest said vibratory arm.

9. In combination, a phonographic record; a needle engaging the sound-interlineations thereon; a rod for transmitting the vibrations resulting from said engagement to a point beyond the range of the synchronous sympathetic vibrations of said needle; vibratory arms each fulcrumed mediate their length and carried by said rod; and means for reproducing said vibrations at the end of said rod nearest said vibratory arm.

10. In combination, a phonographic record; a needle engaging the sound-interlineation thereon; a fulcrumed rod for transmitting the vibrations resulting from said engagement to a point beyond the range of the synchronous sympathetic vibrations of said needle; vibratory arms each fulcrumed mediate their length and carried by said rod; and means for reproducing said vibrations at the end of said rod nearest said vibratory arm.

11. In combination, a phonographic record; a needle engaging the sound-interlineations thereon; a yieldingly-fulcrumed rod for transmitting the vibrations resulting from said engagement to a point beyond the range of the synchroneous sympathetic vibrations of said needle; vibratory arms each fulcrumed mediate their length and carried by said rod; and means for reproducing said vibrations at the end of said rod nearest said vibratory arm.

12. In combination, a phonographic record; a needle engaging the sound-interlineations thereon; a rod for transmitting the vibrations resulting from said engagement to a point beyond the range of the synchronous sympathetic vibrations of said needle; adjustable vibratory arms each fulcrumed mediate their length and carried by said rod; and means for reproducing said vibrations at the end of said rod nearest said vibratory arm.

13. In combination, a phonographic record; a needle engaging the sound-interlineations thereon; a rod for transmitting the vibrations resulting from said engagement to a point beyond the range of the synchronous sympathetic vibrations of said needle; adjustable fulcrumed vibratory arms each pivoted mediate their length and carried by said rod; and means for reproducing said vibrations at the end of said rod nearest said vibratory arm.

14. In combination, a phonographic record; a needle engaging the sound-interlineations thereon; a yieldingly-fulcrumed rod for transmitting the vibrations resulting from said engagement to a point beyond the range of the synchronous sympathetic vibrations of said needle; adjustable fulcrumed vibratory arms each pivoted mediate their length and carried by said rod; and means for reproducing said vibrations at the end of said rod nearest said vibratory arm.

15. In combination, a phonographic record; a needle engaging the sound-interlineations thereon; a rod for transmitting the vibrations resulting from said engagement to a point beyond the range of the synchronous sympathetic vibrations of said needle; vibratory arms carried by said rod that are fulcrumed mediate their length and adjustable independent of each other; and means for reproducing said vibrations at the end of said rod nearest said vibratory arm.

[fol. 248] 16. In combination, a phonographic record; a needle engaging the sound-interlineations thereon; a fulcrumed rod for transmitting the vibrations resulting from said engagement to a point beyond the range of the synchronous sympathetic vibrations of said needle; vibratory arms carried by said rod that are fulcrumed mediate their length and adjustable independent of each other; and means for reproducing said vibrations at the end of said rod nearest said vibratory arm.

17. In combination, a phonographic record; a needle engaging the sound-interlineations thereon; a yieldingly-fulcrumed rod for transmitting the vibrations resulting from said engagement to a point beyond the range of the synchronous sympathetic vibrations of said needle; vibratory arms carried by said rod that are fulcrumed mediate their length and adjustable independent of each other; and means for reproducing said vibrations at the end of said rod nearest said vibratory arm.

18. In combination, a phonographic record; a needle engaging the sound-interlineations thereon; a rod for transmitting the vibrations resulting from said engagement to a point beyond the range of the synchronous sympathetic vibrations of said needle; adjustable vibratory arms carried by said rod that are fulerumed mediate their length and adjustable independent of each other, and means for reproducing said vibrations at the end of said rod nearest said vibratory arm.

19. In combination, a phonographic record; a needle engaging the sound-interlineations thereon; a road for transmitting the vibrations resulting from said engagement to a point beyond the range of the synchronous sympathetic vibrations of said needle; adjustable fulerumed vibratory arms carried by said rod that are pivoted mediate their length independent of each other; and means for reproducing said vibrations at the end of said rod nearest said vibratory arm.

20. In a phonograph, the combination with a record having superficial sound-interlineations thereon, and mechanism for revolving the same; of devices engaging said sound-interlineations, consisting of a horizontal rod extending from within the circumference of said record to a point beyond the same; a needle carried on the inner end thereof and adapted to engage said interlineations; a vibratory arm mounted on the opposite end of said rod; and disconnected means for audibly reproducing the vibrations caused by the engagement between said needle and said interlineations.

In testimony whereof I have hereunto set my hand this 10th day of February, A. D. 1905.

Frank F. Shanks.

Witnesses: Frank D. Thomason, E. K. Lundy.

(Here follow drawings, side folios 249 and 250)

No. 857,209. PATENTED JUNE 18, 1907.

W. C. SMITH.

SOUND PRODUCING DEVICE.

APPLICATION FILED OCT. 6, 1906.

2 SHEETS—SHEET 1.

Fig 1

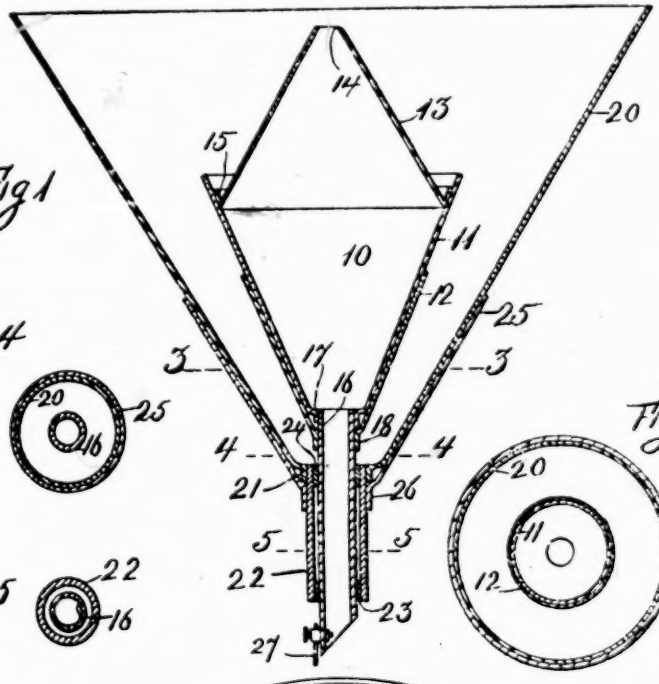


Fig 4

Fig 3

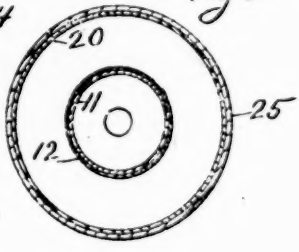
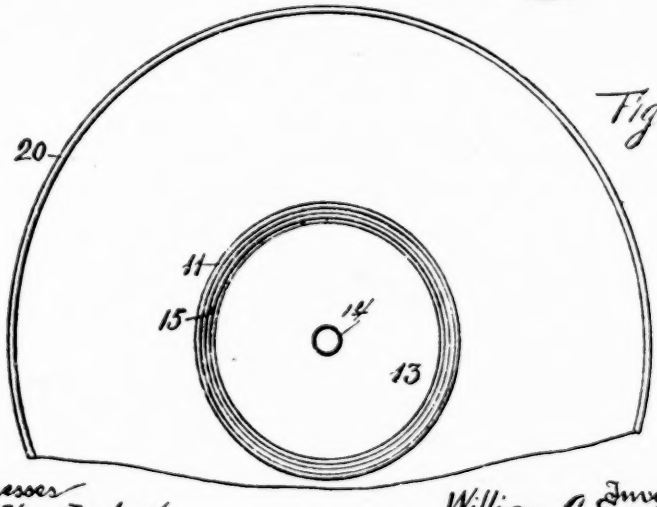


Fig 5

Fig 2



Witnesses
S. G. Van Derbeck
M. M. Cook

Inventor
William C. Smith
By his Attorney
Alfred Bonneville

No. 857,209. PATENTED JUNE 18, 1907.

W. C. SMITH.

SOUND PRODUCING DEVICE.

APPLICATION FILED OCT. 8, 1906.

2 SHEETS—SHEET 2.

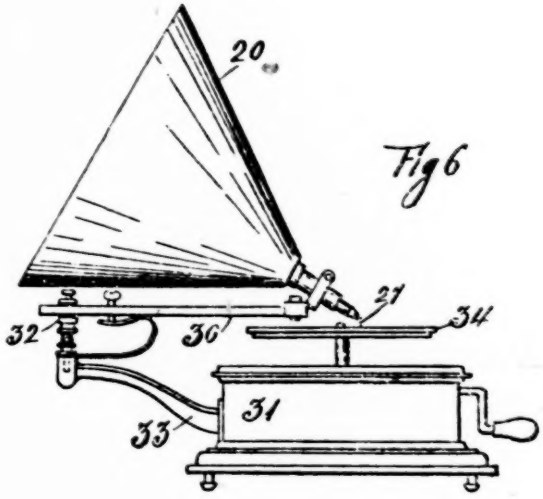


Fig 6

Witnesses
S. G. Van Dorbeck.
M. M. Cook.

Inventor
William C. Smith
By his Attorney
Albert Bonnerville

[fol. 251] United States Patent Office

William C. Smith, of Paterson, New Jersey

Sound-producing Device

Specification of Letters Patent

No. 857,209. Patented June 18, 1907

Application Filed October 5, 1906. Serial No. 337,620

To all whom it may concern:

Be it known that I, William C. Smith, a citizen of the United States, and a resident of Paterson, in the county of Passaic and State of New Jersey, have invented certain new and useful improvements in Sound-Producing Devices, of which the following is a specification:

This invention relates to a sound producing device which is specially applicable to talking machines and the like. Its organization comprises means for producing sound without the metallic effects of ordinary horns and vibrating diaphragms, securing also full loud tones, which are generally not obtained with apparatus that produces soft and modulated notes.

In the drawings Figure 1 represents a vertical axial section of the invention, Fig. 2 is a partial top plan view of Fig. 1, Fig. 3 is a section of Fig. 1 on the line 3, 3, Fig. 4 shows a section of Fig. 1 on the line 4, 4, Fig. 5 represents a section of Fig. 1 on the line 5, 5 and Fig. 6 shows a talking machine with my invention connected therewith.

The invention is shown to comprise an inner horn 10, which consists of the conical sides 11 connected to the conical supports 12, and covered with the cap 13 having the opening 14 in its apex. The cap 13 has formed at its lower edge the flange 15 which joins with the walls 11 a little below the upper end thereof. An inner tube 16 extends from the conical sides 11, a flange 17 of the sides 11 making the necessary connection between the tube 16 and the sides 11. A flange 18 extends from the support 12 and is also connected with the inner tube.

On the outside of the horn 10 is located the outer horn 20 which has the flange 21 extending therefrom, and the

latter is joined with an outer tube 22 that encircles the inner tube 16, and is held in place by the sound insulating rings 23 and 24 (preferably of rubber) which separate the said tubes. A secondary conical support 25 joins with the horn 20, has the flange 26, which latter is secured to the outer tube 22. A stylus 27 extends from the tube 16 in the usual way.

In Fig. 6 I have represented the horn 20 supported by means of an arm 30 of a talking machine 31. The arm 30 is adjustably held in a clamp 32, that is pivoted to a bracket 33 of the talking machine.

The tubes 16 and 22 are preferably made of bamboo stems, although other fibrous material may be used. The outer tube 22 need not necessarily be made of fibrous material.

The inner horn 10 is generally made of paper and the like material, while the outer horn may be of fibrous or other material.

To use the invention it is connected to a talking machine as shown in Fig. 6, the record imparting through the stylus 27 vibrations to the inner tube 16, which vibrations are amplified by the inner horn 10, and modulated by its cap 13. Sound waves recede from the horn 10 and are diffused by means of the outer horn 20, the latter performing the function of a megaphone, carrying and increasing the loudness of the sound coming from the inner horn #10. The sound insulating rings 23 prevent sound waves being directly transmitted from the inner tube to the walls of the outer horn.

Having described *by* invention I claim:

1. In a sound producing device the combination of an inner tube, a horn extending therefrom, an outer tube encircling said inner tube, a sound insulator between the tubes, and a horn extending from the outer tube.

2. In a sound producing device the combination of an inner tube, a horn extending therefrom, an outer tube encircling said inner tube, a sound insulator between the tubes, a horn extending from the outer tube, and a stylus extending from the inner tube.

3. In a sound producing device the combination of an inner tube of bamboo, a horn extending therefrom, an outer tube of bamboo encircling said inner tube, a sound insu-

No. 890,142. PATENTED JUNE 9, 1908.

T. KRAEMER.

SOUND BOX FOR TALKING MACHINES.

APPLICATION FILED OCT. 7, 1907.

Fig. 1,

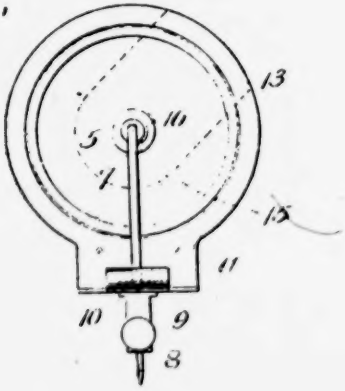


Fig. 2,

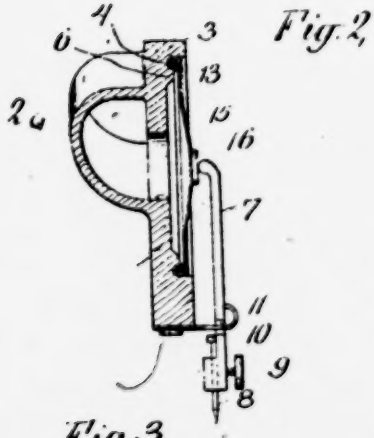


Fig. 3,

WITNESSES:

INVENTOR

Thomas Kraemer,

BY J. C. Edmunds

ATTORNEY

lator between the tubes, a horn extending from the outer tube, and a stylus extending from the inner tube.

4. In a sound producing device for a talking machine the combination of an inner tube of bamboo, a conical horn extending from the tube, a sound insulator around the tube, an outer tube of bamboo around the insulator, and a conical horn extending from the outer tube.

5. In a sound producing device the combination of an inner tube, a horn extending therefrom, a cap having an opening connected with the horn, an outer tube encircling said inner tube, a sound insulator between the tubes, a horn extending from the outer tube and encircling the other horn.

6. In a sound producing device the combination of an inner tube, a horn extending therefrom, a conical support [fol. 252] for the horn supported on the said tube, a cap having an opening secured to the horn, an outer tube encircling the inner tube, sound insulating rings between the outer surface of the inner tube and the inner surface of the outer tube, a horn extending from the outer tube, a support for the outer horn secured to the outer tube, and a stylus connected with the inner tube.

7. In a sound producing device for a talking machine the combination of an inner tube of bamboo, a paper horn having a flange, the flange fastened to the tube, a conical paper support for the horn having a flange, the latter secured to the tube, a pair of rubber sound insulators around the tube, an outer tube of bamboo around the insulators, an outer paper horn having a flange with the latter fastened to the outer tube, a conical paper support for the outer horn having a flange with the latter fastened to the outer tube.

Signed at the borough of Manhattan in the county of New York and State of New York this 4th day of October A. D. 1906.

William C. Smith.

Witnesses: S. G. Van Derbeck, M. H. Cook.

(Here follows drawing, side folio 253)

[fol. 254] United States Patent Office

Thomas Kræmer, of Philadelphia, Pennsylvania, Assignor to Hawthorne & Sheble Manufacturing Company, of Philadelphia, Pennsylvania, a Corporation of Pennsylvania

Sound-Box for Talking-Machines

Specification of Letters Patent

No. 890,142. Patented June 9, 1908

Application filed October 7, 1907. Serial No. 396,135

To all whom it may concern:

Be it known that I, Thomas Kræmer, a citizen of the United States, residing at Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented a certain new and useful Improvement in Sound-Boxes for Talking-Machines, of which the following is a specification.

This invention relates to sound-boxes for talking machines and has reference more particularly to the construction of the diaphragms for such sound-boxes.

The object of the invention is to effect certain improvements in the construction of such diaphragms to the end that a greater volume of sound is obtained in reproducing a record and that a more faithful reproduction is obtained as a result of the elimination of false sound vibrations.

I have illustrated the preferred embodiment of my invention in the accompanying drawings, in which

Figure 1 is a front view of a sound-box, Fig. 2 is a central section of the same, and Fig. 3 is an enlarged sectional view of the diaphragm alone.

Referring to these drawings, the sound-box is shown as having a main wall 1, a tubular extension 2 leading therefrom for connection to the sound conveying tube, and a circular flange 3 at the outer edge of wall 1 forming the outer wall of the box. Fitting snugly within wall 3 is a rubber strip or ring 4, circular in cross-section, forming a support for the diaphragm 5, this ring being retained in position by a circular ridge 6 integral with and rising from the wall 1. The stylus-lever 7 is pivotally mounted upon the wall 3,

bears at its inner end upon the central portion of the diaphragm, and at its outer end is provided with an opening to receive a stylus 8, the latter being held in its opening by a setscrew 9. In the present instance, I have shown the stylus-lever as provided with notched lugs 10 adapted to receive knife-edges formed on a sheet-metal piece 11 which is secured to wall 1 and whose end forms a spring 12 tending to rock the stylus-lever on its knife-edge pivot in the direction to hold its inner end against the diaphragm.

The method of mounting the diaphragm herein shown with its edge bearing on a rubber ring has proven highly efficient as the rubber absorbs counter-vibrations and thus makes the reproduced sound much more clear. The diaphragm, which is a disk of thin sheet-metal, is of a diameter but little less than the internal diameter of the circular flange 3 and when in proper position it rests upon the rubber ring 4 with its outer edge separated from the interior wall of flange 3 by a narrow space entirely around the diaphragm. It is difficult, however, to get the diaphragm in its position every time it is inserted and to retain it there during long periods of use of the sound-box and if the diaphragm becomes moved out of this position the small amount necessary to carry its edge into contact with the flange 3, the vibrations of the diaphragm will be transmitted to the sound-box and the reproduced sound will be much less clear and distinct. I therefore provide means for centering the diaphragm in position and holding it against such movement as would cause its edge to engage the wall of the box. This is accomplished by providing a circular rib 13 in the diaphragm concentric with and close to the outer edge thereof, such that when the diaphragm is in position, this rib will coact with the rubber ring 4 to obstruct movement of the diaphragm in the plane in which it lies.

In Fig. 2 of the drawings, it will be seen that the rib 13 is in coaction with the ring 4 and would preclude movement of the diaphragm in a vertical direction and that when in this position the edges of the diaphragm are separated from the wall of the sound-box. So long as the diaphragm is held in this position, the danger of transmitting the vibrations thereof to the walls of the sound-box is eliminated.

In diaphragms for sound-boxes as heretofore constructed, especially those which are flat disks, the vibrating area is

small and therefore the air-pressure behind the diaphragm is also small. In accordance with my invention, I construct the diaphragm in such manner that the area of vibration is considerably increased. This is accomplished by pressing a comparatively large portion of the diaphragm at its center out of the plane thereof so that the central portion of the diaphragm swells out to one side. This is shown in Figs. 2 and 3, from which it will be seen that the center 14 of the diaphragm is displaced from the plane of the edge portion [fol. 255] thereof. The inclined portion 15 joining the center 14 and the edge portion includes a considerable part of the total area of the diaphragm and when the stylus-lever is rocked to and fro on its pivot by the undulations of the record-groove, this entire inclined portion is caused to vibrate so that a vibrating area is obtained which is considerably larger than that obtained when a flat disk is employed as a diaphragm. This increased area of vibration results in increased air-pressure behind the diaphragm and both of these combine to give a considerably increased volume of reproduced sound.

The diaphragm above described may be pressed to the desired shape from a disk of sheet-metal and may therefore be manufactured at very low cost. A metallic button 16 is preferably secured to the center of the diaphragm on which the inner end of the stylus-lever bears.

Having now described my invention, what I claim as new therein and desire to secure by Letters Patent is as follows:

1. The combination of a sound-box having an outer wall, a resilient member within said wall, and a diaphragm supported on said member with its edge out of contact with said wall, said diaphragm having a rib therein coacting with said member to prevent movement of the diaphragm in the plane in which it lies, substantially as set forth.

2. The combination of a sound-box having an outer wall, a rubber ring within said wall, a ridge on the sound-box to retain said ring in position, and a diaphragm supported on said ring with its edge out of contact with said wall, said diaphragm having a rib therein close to its outer edge coacting with said member to prevent movement of the diaphragm in the plane in which it lies, substantially as set forth.

T. A. EDISON.

APPARATUS FOR RECORDING OR REPRODUCING SOUNDS.

APPLICATION FILED MAY 24, 1905.

963,362. Patented July 5, 1910.

Fig. 1.

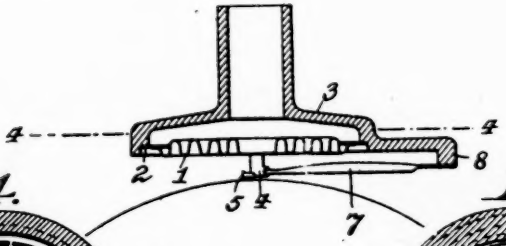


Fig. 4.

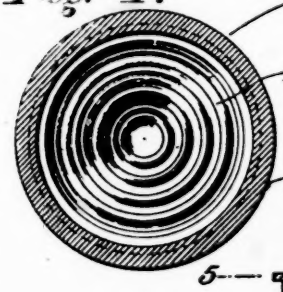


Fig. 5.

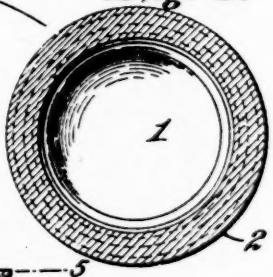


Fig. 2.

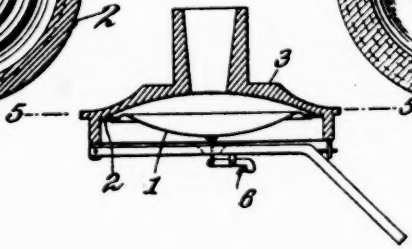
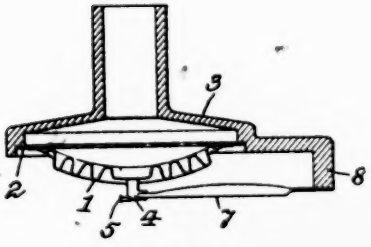


Fig. 3.



Witnesses:
Edgerton Bacon
Minig C. MacArthur

Inventor
Thomas A. Edison
by Frank L. Dyer
Attorney.

3. The combination of a sound box having a wall and shaped to provide a surface within the box adjacent to said wall for supporting a diaphragm, and a diaphragm supported on said surface, said diaphragm having a rib therein coacting with a part of the box structure to preclude movement of the diaphragm in the plane in which it lies to carry its edge into engagement with said wall of the box, substantially as set forth.

This specification signed and witnessed this 30 day of Septr., 1907.

Thomas Kræmer.

Witnesses: H. Meier, H. Muhlschlegel.

(Here follows drawing, side folio 256)

[fol. 257] United States Patent Office

Thomas A. Edison, of Llewellyn Park, Orange, New Jersey

Apparatus for Recording or Reproducing Sounds

Specification of Letters Patent

963,362. Patented July 5, 1910

Application Filed May 24, 1905. Serial No. 261,950

To all whom it may concern:

Be it known that I, Thomas A. Edison, a citizen of the United States, residing at Llewellyn Park, Orange, in the county of Essex and State of New Jersey, have invented certain Improvements in Apparatus for Recording or Reproducing Sounds (Case B,) of which the following is a description.

My invention relates to various new and useful improvements in apparatus for recording or reproducing sounds, and my object is to provide an apparatus for the purpose which shall permit a more accurate recording of the sound waves free from waves or disturbances, due to the recording mechanism itself, and a more accurate reproduction of the same than is possible by methods and apparatus heretofore known.

In an application for Letters Patent filed on even date herewith, and relating to methods of recording or reproducing sounds, I have pointed out the cause or origin of the false, discordant and inharmonic sounds which are created within the recording mechanism, and which become recorded to affect the character of the reproduction.

With diaphragms as now made a thin plate, or a series of superposed plates, of greatly reduced diameter has been tightly clamped at the edge, so that any vibration mst take place by the flexing or bending of the diaphragm itself. Such a diaphragm, moreover, acts practically as a reed and produces a note of its own, so that it vibrates sympathetically with certain notes within the range of music, and thereby produces inharmonic resultant tones which become recorded with the other sounds. Furthermore, such a diaphragm, in vibrating vibrates locally so as to form a large number of nodes, as has been demonstrated by the production of the so-called Chaladni figures, and these vibratable local areas are also probably responsive to certain musical tones or overtones to result in the production of certain extraneous sounds, which become recorded and mar the reproduction. Moreover, such a diaphragm, owing to its clamped edges, vibrates with relative difficulty, and, hence, is not as sensitive as it should be; and, since it vibrates locally, the local vibrations are not communicated to the recording stylus, and, consequently, a proportionate loss of energy takes place to weaken the recorded sounds.

Notwithstanding the inherent lack of sensitiveness which is characteristic of ordinary diaphragms, the fact is that in the attempt to obviate the production of the inharmonic sounds referred to, it has been the practice to purposely further diminish the sensitiveness of the diaphragm to such an extent that the volume or strength of the inharmonic sounds is reduced so that they are not so prominent; but this practice has been ineffective for the purpose, and the diaphragms are so lacking in sensitiveness that the delicate overtones which accompany the fundamental tones, and which give to music its pleasing quality, are weakened in most cases so as to be practically inaudible, while distortion of the sound sought to be recorded is produced.

In correcting the faults which exist in diaphragms as now constructed, I have produced a diaphragm which is en-

tirely free from any audible fundamental tone or overtone of its own, and which, therefore, does not vibrate sympathetically with any tones within the range of music. I thus prevent not only the distortion of the original sound waves, but I also prevent the production of inharmonic sounds, such as are produced with diaphragms as heretofore made. Furthermore, my improved diaphragm can be and is extremely sensitive, so as to accurately respond to and effect the recording of all fundamental tones as well as their overtones. Finally, with my improved diaphragm, inertia due to weight is reduced to a minimum, and, consequently false vibration caused by overthrow and retardation is largely overcome, this being especially true in the case of vibrations of high frequency. I attain this result by employing a rigid diaphragm of a novel type, which, instead of vibrating in the usual way, vibrates as a whole, the entire displacement taking place at the edges, and I employ with that diaphragm at the periphery thereof an extension or continuation of soft pliable yielding material so as to operate practically as a hinge, the whole having no audible tone within the range of music. I have constructed diaphragms of extreme lightness, and, at the same time, so rigid that the loudest sounds ordinarily used in the art do not set any special local area in vibration sufficient to produce Chaladni figures, so that the whole vibrates or follows the sound waves with great accuracy by being forced.

[fol. 258] In order that the invention may be better understood, attention is directed to the accompanying drawings, forming part of this specification and in which:

Figure 1, is a sectional view of a suitable recording apparatus embodying my present improvements, showing a flat corrugated diaphragm; Fig. 2, a similar view of a reproducing apparatus embodying my improvements showing a dished or concave diaphragm; Fig. 3, a similar view of a recording apparatus, embodying my invention and showing a diaphragm that is both corrugated and dished; Fig. 4, a plan view of the diaphragm shown in Figs. 1 and 3, and Fig. 5, a plan view of the diaphragm shown in Fig. 2.

In all of the above views, corresponding parts are represented by the same numerals of reference.

A diaphragm 1, is shown in Figs. 1 and 4 as being provided with concentric corrugations, made so deep that the

diaphragm acts as a rigid body to sound waves, and vibrates to and fro like a piston without bending or flexing at the center, as with ordinary diaphragms clamped at the edges. The rigidity of the diaphragm is such that if clamped at the edges in the usual way it would not vibrate under the effect of sounds or ordinarily used in this art. Furthermore, the diaphragm is so rigid that it is free from local vibrations which with ordinary diaphragms produce Chaladni figures. The diaphragm shown in Figs. 2 and 5 is dished or scooped for the same purpose, but this is not quite so effective when deep corrugations are used. In any case, the diaphragm should be as light as possible, and be stiff enough to vibrate as a rigid body. It will, therefore, be understood, that the diaphragms may be both dished and corrugated, as shown in Fig. 3, in order that metal of exceeding thinness can be used. Preferably the diaphragm is made of very thin metallic magnesium, which is extremely light and very rigid when corrugated, particularly when both dished and corrugated, and very thin sheets can be used—much thinner in fact than with glass diaphragms as now commonly employed. To this rigid piston-like diaphragm is secured around its outer edge a ring 2, preferably of soft rubber, which is held in place by shellac or other cement, so as to form practically a yielding extension of the diaphragm, and which, when the diaphragm vibrates to and fro, vibrates practically as a hinge having a negligible resistance. The ring 2, may be made of other materials than rubber, such as leather, paper, thin collodion, etc., but thin rubber tissue is preferable for obtaining great sensitiveness. This ring 2, is cemented or otherwise secured without tension to any suitable arrangement of head or body 3, with which a speaking tube, listening tube or horn may be connected

When used for recording purposes a foot 4, carrying a suitable recording stylus 5 (Figs. 1 and 3), is cemented or otherwise secured to the diaphragm. When used with a reproducer, a reproducing stylus 6 (Fig. 2) is preferably pivoted to the usual floating weight and connected to the diaphragm by a link in the usual way.

In order to take the thrust imposed by the rotation of the recording surface with respect to the recording stylus, I extend a link 7, between the foot 4, and an arm 8, depending

from the head 3, said link being made preferably of wood so as to be very light, and having its vertical dimension greater than its transverse dimension, and of constantly varying section reduced to a very thin leaf at the end where it is secured to the arm 8, whereby the formation of nodes will be prevented and the fundamental tone of the link be so grave as to be below the range of ordinary music, as I describe and claim in my application, filed November 13, 1903, Serial No. 180,998. When the diaphragm vibrates it follows the very slight arc which the free end of the link describes, the yielding ring 2, permitting the diaphragm to move laterally to the desired extent, so that there is no cramping in operation.

Since the diaphragm can vibrate only to and fro as a rigid body, like a piston, any yielding is necessarily confined to and takes place entirely within the small free portion of the ring 2, extending between the diaphragm and the cement which holds the ring in place. This yielding section can have no audible local disturbing tone; and hence, all of its movements, as well as those of the diaphragm, are forced, and the recorder is, therefore, caused to accurately follow the sound waves.

Since the action of the diaphragm is analogous to that of a piston subjected to pressure, first on one side and then on the other, it follows that any movements of the yielding section or bulging thereof beyond the movement of the diaphragm will diminish the amplitude of the latter, and for this reason the yielding section should be very thin and the area very small. In practice, I increase the diameter of the rigid diaphragm to as great an extent in proportion to the yielding material as possible, the latter being usually about six per cent. of the whole area. In this way I concentrate nearly the whole of the condensations and rarefactions of the sound waves upon the diaphragms proper, so as to cause it to give the maximum response thereto, and prevent, to the greatest possible extent, loss of pressure due to yielding of the yielding section.

[fol. 259] When a rigid diaphragm of my improved type is used in connection with reproducing apparatus a number of advantages are secured, as when employed with a recording apparatus. In the first place, owing to its extreme sensitiveness, the diaphragm accurately follows and re-

sponds to the recorded sounds; and, owing to its extreme lightness, inertia is reduced to a minimum so as to reduce the tendency of the diaphragm to leave the record, particularly when the recorded waves are very deep or of high frequency. Furthermore, the great lightness of the diaphragm materially reduces wear upon the unrecorded surface. In the next place, since the diaphragm is free from any fundamental tone or overtone of its own, it cannot respond sympathetically with any of the recorded sounds to thereby distort the reproduction and make it inharmonic. Finally, since the diaphragm is incapable of vibrating locally, the creation of extraneous sounds from that cause in the reproduction is also overcome.

While I have described my improved apparatus in connection with the recording and reproduction of sounds phonographically, and wherein the recorded forms, or the reproducer follows, a record of varying depth, it will be understood that the apparatus can be effectively utilized with machines of the gramophone type, wherein a zig-zag record groove is formed, it being only necessary in the latter case to connect the diaphragm with a recorder adapted to form, or with a reproducer adapted to follow, such a zig-zag record groove.

Having now described by invention what I claim as new therein and desire to secure by Letters Patent is as follows:

1. In apparatus for recording or reproducing sounds, the combination of a body and a very thin diaphragm formed of a light metal, said diaphragm being dished or concave, and provided with deep concentric corrugations, said diaphragm being connected to said body by a hinge of a material having greater pliability than that of the diaphragm, substantially as set forth.

2. In apparatus for recording or reproducing sounds, the combination of a body and a very thin diaphragm formed of magnesium, said diaphragm being dished or concave, and provided with deep concentric corrugations, said diaphragm being connected to said body by a hinge of a material having greater pliability than that of the diaphragm, substantially as set forth.

3. In apparatus for recording or reproducing sounds, a very thin diaphragm formed of a light rigid and elastic metal, said diaphragm being dished or concave for practically its whole width, and provided throughout with deep concentric corrugations, substantially as set forth.

4. In apparatus for recording or reproducing sounds, the combination with a body and a diaphragm secured thereto by a hinge of yielding material so as to be capable of lateral movement, or a stylus connected to said diaphragm and a light rod anchored at one end and connected at its other end to said stylus for receiving the thrust thereof, said rod being so shaped as to give forth no audible tone in vibrating, substantially as set forth.

5. A diaphragm made of metallic magnesium and having a concave portion formed with concentric corrugations, substantially as set forth.

6. A diaphragm made of metallic magnesium and united to a circumferential section of small area composed of material having greater pliability than magnesium and which is adapted to operate as a hinge under the movements of the diaphragm, substantially as set forth.

This specification signed and witnessed this 20th day of May, 1905.

Thos. A. Edison.

Witnesses: Frank L. Dyer, Anna R. Klehm.

Corrections in Letters Patent No. 963,362

It is hereby certified that in Letters Patent No. 963,362, granted July 5, 1910, upon the application of Thomas A. Edison, of Llewellyn Park, Orange, New Jersey, for an improvement in "Apparatus for Recording or Reproducing Sounds," errors appear in the printed specification requiring correction as follows: Page 2, line 37, after the word "effective" the word *as* should be inserted; page 3, line 19, the word "recorder" should read *recorded;* and that the said Letters Patent should be read with these cor-

rections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 20th day of September, A. D. 1910.

C. C. Billings, Acting Commissioner of Patents.

(Seal.)

(Here follow drawings, side folios 260, 261, 262, 263, and 264)

[fol. 265] United States Patent Office

Louis Lumiere, of Lyon, France

Acoustical Instrument

Specification of Letters Patent

986,477. Patented Mar. 14, 1911

Application Filed June 30, 1909. Serial No. 505,149

To all whom it may concern:

Be it known that I, Louis Lumiere, a citizen of the Republic of France, residing at Lyon, in the Republic of France, have invented certain new and useful Improvements in Acoustical Instruments, of which the following is a full, clear, and complete disclosure.

This invention relates to improvements in acoustical instruments, such as telephones, microphones, sound recording and reproducing machines, and musical instruments in general. As applied to sound recording and reproducing apparatus, it relates more particularly to that part of the instrument which is generally known as the diaphragm, or the body which in the process of sound recording is thrown into vibration by the sound waves, and whose vibrations are traced and recorded by means of a stylus in the original record, while in the process of reproduction the diaphragm, (as a general rule, the diaphragm of a separate machine), is thrown into corresponding vibrations by a stylus to which it is attached being made to follow the undulations in the record.

L. LUMIERE.

ACOUSTICAL INSTRUMENT.

APPLICATION FILED JUNE 30, 1909.

986,477. Patented Mar. 14, 1911.

5 SHEETS—SHEET 1.

Fig. 1.

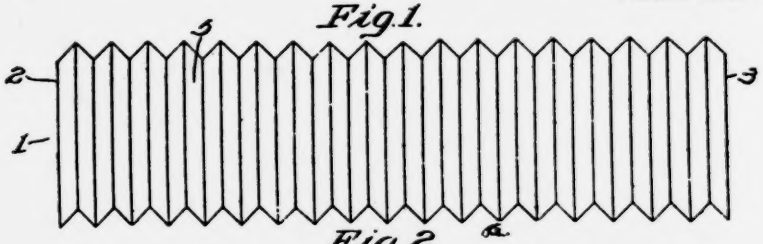


Fig. 2.

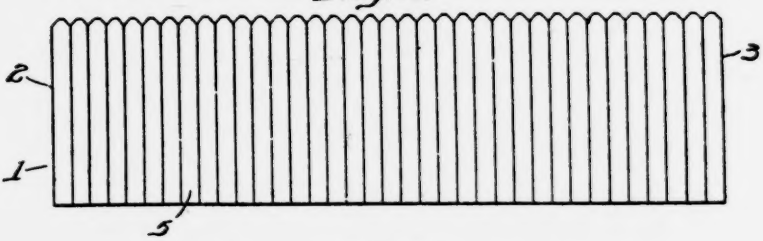


Fig. 3.

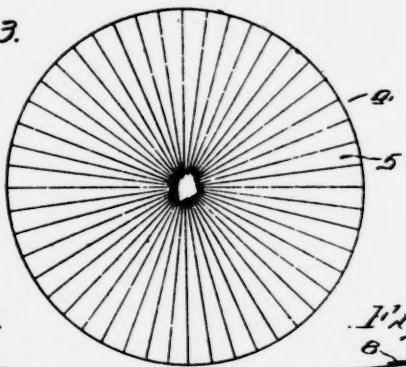


Fig. 4.

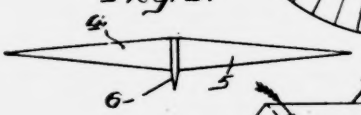


Fig. 5.

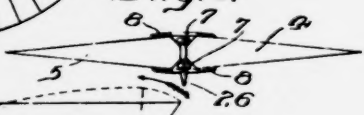
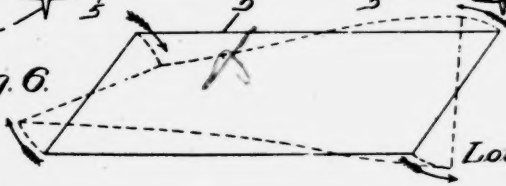


Fig. 6.



INVENTOR

Louis Lumiere

WITNESSES

H. J. Hartman.

Horace P. Miller Jr.

BY

ATTORNEY

L. LUMIERE.

ACOUSTICAL INSTRUMENT.

APPLICATION FILED JUNE 30, 1909.

986,477. Patented Mar. 14, 1911.

5 SHEETS—SHEET 3.

Fig. 7.

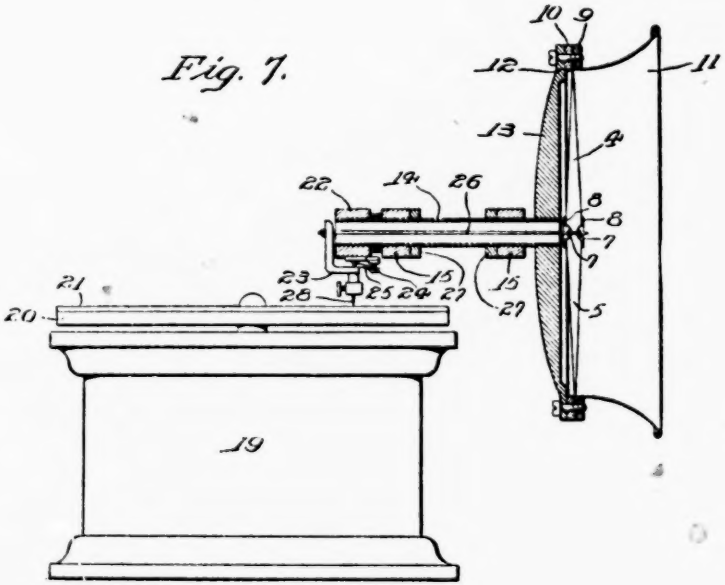
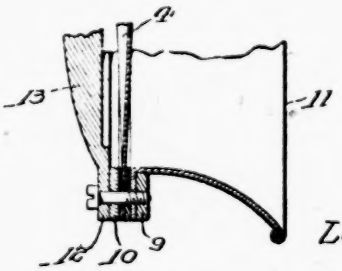


Fig. 7ª



WITNESSES

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Alston B. Moulton

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BY Howe Pettit.

ATTORNEY

L. LUMIERE.

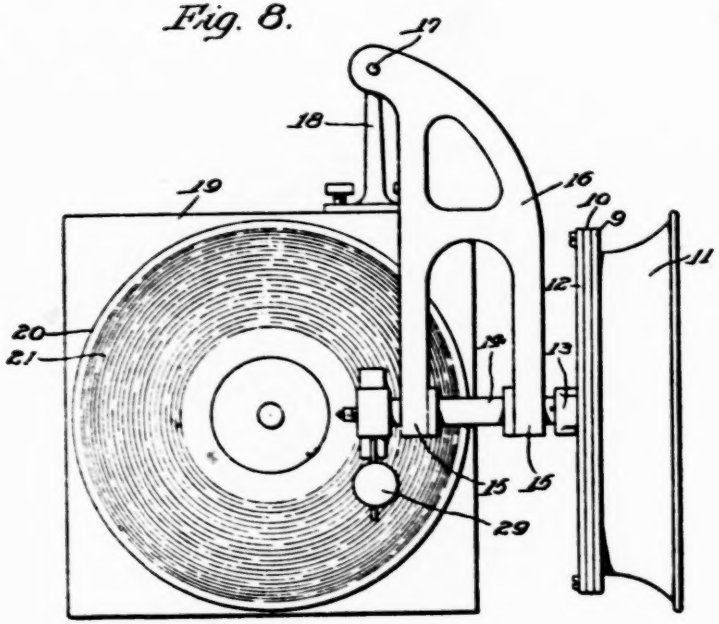
ACOUSTICAL INSTRUMENT.

APPLICATION FILED JUNE 30, 1909.

986,477. Patented Mar. 14, 1911.

6 SHEETS—SHEET 3.

Fig. 8.



INVENTOR

Louis Lumiere.

WITNESSES

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ATTORNEY

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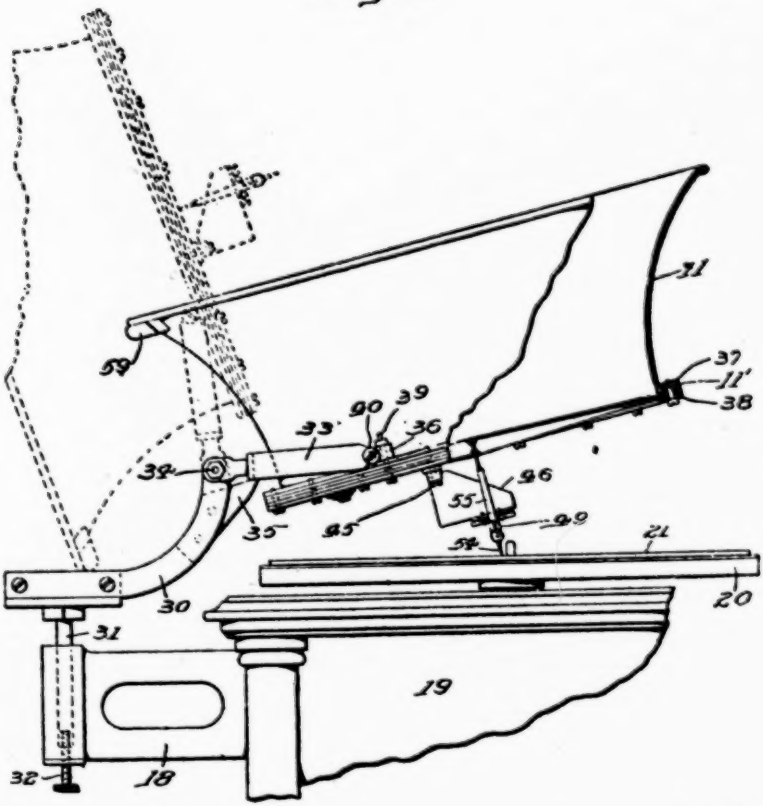
ACOUSTICAL INSTRUMENT.

APPLICATION FILED JUNE 30, 1909.

986,477. Patented Mar. 14, 1911.

5 SHEETS-SHEET 4.

Fig. 9.



INVENTOR

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WITNESSES

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ACOUSTICAL INSTRUMENT.

APPLICATION FILED JUNE 30, 1909.

986,477. Patented Mar. 14, 1911.

5 SHEETS—SHEET 5.

Fig. 10.

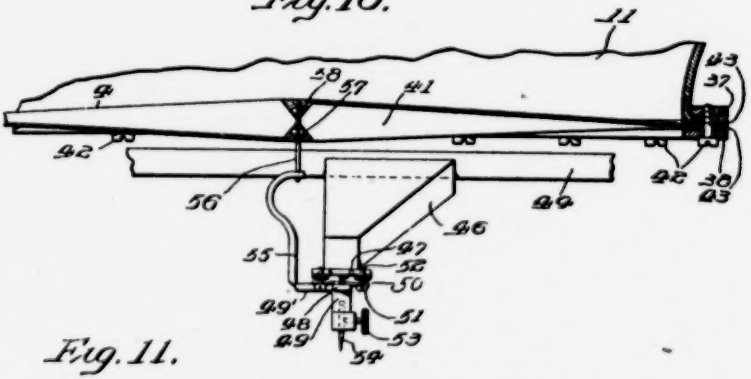
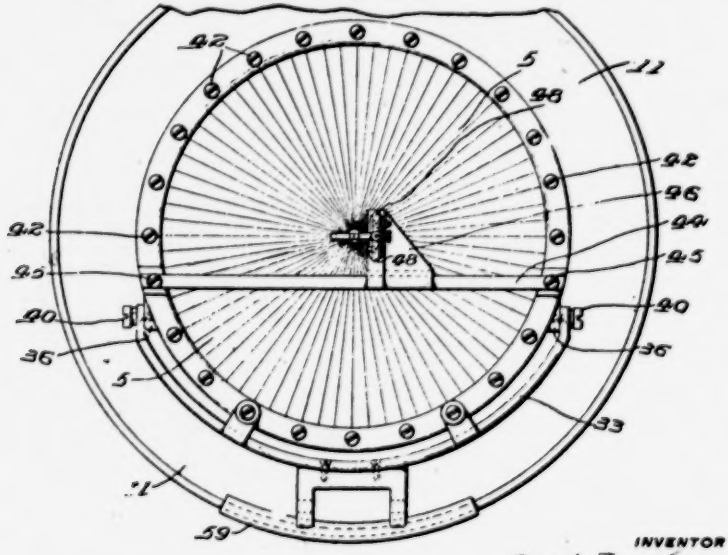


Fig. 11.



INVENTOR

Louis Lumiere.

WITNESSES

F. J. Hartman.

Mabel F. Walker

BY Howe & Ellis.

ATTORNEY

The invention also relates to the sound box in which said diaphragm is mounted.

The object of my invention is to provide a diaphragm and a mounting therefor, by means of which sounds may be faithfully recorded and reproduced, which will be sensitive to sound waves and by the use of which the reproduction of sound will be improved and amplified.

Further objects of my invention are to increase the reproducing surface of a diaphragm, and, at the same time, to place the entire surface under a tension, (preferably torsional), to make it sensitive; to increase the active surface of a diaphragm of a certain given diameter; to increase the diameter of the diaphragm without making it liable to vibrate in parts, or to set up nodes or inactive portions in the diaphragm, or in other words, to substantially increase the size of the diaphragm and, at the same time, have it vibrate throughout; to construct a diaphragm having a plurality of sound responsive elements, each of which is subjected to a molecular tension, and to subject each of a plurality of sound responsive elements to a molecular tension to increase the sensitiveness thereof and to cause them to vibrate as a whole.

Further objects of my invention will be found in the specification and claims below.

The invention consists in a diaphragm for acoustical instruments, having one or more freely resilient, sound responsive surfaces or elements, which have been brought into a condition of molecular stress, of an aggregate superficial area substantially larger than the surface of a plane disk of the same diameter, and in a recorder or reproducer in which said diaphragm is mounted.

It is found that the effect of bringing the surfaces of a vibrating body into a condition of molecular stress by torsion, is to reduce by a minimum the tendency of the vibrating body to form nodes during operation, so that the surface or surfaces of the diaphragm will vibrate as a whole and will not produce the disagreeable effect which is technically known as blasting or shattering.

One construction of diaphragm made according to this invention and the method of making it is illustrated in the accompanying drawings, in which:—

Firgue 1 shows a folded strip of material from which the improved diaphragm may be made: Fig. 2 is a plan view of a modified form of folded strip of material from which a diaphragm may be made; Fig. 3 is a plan view of the diaphragm; Fig. 4 is a sectional elevation of the diaphragm; Fig. 5 is a sectional elevation view of a slightly modified form of diaphragm; Fig. 6 is a diagram to illustrate the way in which the surfaces or elements of the diaphragm are twisted; Fig. 7 is an elevation of a sound reproducing machine fitted with the diaphragm made in accordance with this invention and illustrates a convenient method of carrying the diaphragm and connecting it to the stylus bar; and Fig. 7a is a sectional detail of Fig. 7. Fig. 8 is a plan view of the machine shown in Fig. 7; Fig. 9 is a side elevation view partly in section of a modified form of sound reproducing machine provided with my invention; Fig. 10 is an enlarged view, partly in section, of the diaphragm and stylus bar mounting shown in Fig. 9; and Fig. 11 is a bottom plan view of the reproducer shown in Fig. 9.

According to one method of carrying out this invention, a diaphragm is constructed so that it presents the form shown in Figs. 1, 3, and 4 of the accompanying drawings, in which [fol. 266] the whole surface of the diaphragm on either side consists of a plurality of elements reversely flexed to form a fan-like series of radially disposed ridges and furrows, the ridges on one side of the diaphragm corresponding to the furrows on the other side of the diaphragm, and the furrows gradually widening out and becoming less deep as they approach the edge of the diaphragm until at its perimeter the diaphragm lies in one plane. The elements forming the sides of the ridges and furrows provide the desired freely resilient sound responsive surfaces. A diaphragm of this form may be obtained by folding or plaiting a substantially rectangular strip of paper 1, or other suitable material in the manner shown in Fig. 1. The length of the strip of material before folding should be substantially the length of the circumference of the diaphragm to be formed therefrom, and the width of the strip should be substantially equal to the radius of the said diaphragm. When the strip has been plaited or folded in the manner above described and shown, the ends 2 and 3 should be brought together and secured to each other in any suitable

manner. At this stage of the process or method, the strip will present, roughly speaking, the appearance of a cylinder having fluted sides. This strip of material is then pressed down and forced to assume the form shown in Figs. 3 and 4, one edge of the strip being crimped together at the center, and the other edge forming the perimeter; the radial ridges and furrows, or plaits being closest together and of greatest depth at the center, and gradually opening out and flattening toward the edge where the diaphragm may be held in one plane between clamping rings, as shown in Figs. 7 to 11. In Fig. 3 the diaphragm is designated as 4 and the elements forming the plaits or ridges and furrows are designated by the numeral 5. The diaphragm 4 thus formed in the manner above described will be seen to have a surface formed wholly of a multiplicity of flexed sound responsive elements, reversely sloped or angled to each other, forming dihedral ridges. The surface of the diaphragm will consist of a surface comprising salient radial angled surfaces, and radial reëntrant angled surfaces. Any sector of the surface will have a fan-like formation.

To the center of the diaphragm, is attached, in any suitable manner, the recording or reproducing stylus 6, as the case may be. As shown in Fig. 4, the diaphragm is for use with or for a record having an up and down, or vertical cut, since the diaphragm is directly provided with a stylus at its center.

For making the attachment between the stylus and diaphragm, or between the connection between the stylus and the diaphragm, I prefer to bevel off the inner edge of the diaphragm as particularly shown in Figs. 2, 9 and 10. The stylus 6 may be secured directly to the inner edges of the elements of the diaphragm by being cemented or glued thereto in the manner shown in Fig. 4, or it may be secured in place by means of nuts 7, as will be more particularly described below, in connection with the form of apparatus shown in Figs 9 and 10 and also as shown in Fig. 5. The stylus 6 may also be surrounded by rings of stiff paper 8, secured on either side of the diaphragm at the center thereof to give it additional rigidity at that point. I do not, however, limit myself to this form of connection. The effect of constructing the diaphragm in this manner, is that the whole diaphragm, i. e., the surface of each element of

each ridge and furrow is under molecular stress, produced by torsion, but the sides of the ridges and furrows are twisted out of the plane in which they lie at the center of the diaphragm into a plane, practically at right angles thereto at the circumference of the diaphragm. I have further found that in a diphragm produced by this means, the tendency of the vibrating body to form nodes during operation is reduced to a minimum. The surface of each of the elements composing this diaphragm being helicoidal, and since each point in the vibrating body, as it moves, follows a direction normal to the tangential plane at this point, the result is that the direction of movement is different for each point that has to be considered so that the formation of nodes is practically impossible. It is obvious, of course, that the same condition of molecular stress would be produced upon twisting a sheet of material which naturally possessed a helicoidal or other than plane form so as to take up a position in a true plane, or other helicoidal form of different pitch.

The diaphragm shown in Fig. 6, illustrates clearly the torsion which is applied to each of the multiple surfaces or elements of the diaphragm when the strip of material is made to take up the form shown in Figs. 3 and 4 from the form shown in Fig. 1. In this diagram 5′ represents a thin flat sheet of elastic material, such as is formed by each of the several folds or plaitings of the strip shown in Figs. 1 and 2. If the two ends of this sheet are turned in opposite directions, as indicated by the arrows, and are made to take up the position shown in dotted lines, it is found that a very resilient body is formed, which is capable of vibrating more readily, and is more sensitive, i. e., more sound responsive in its new position than it was before. This is probably due to the molecular stress which is imparted to it by this twisting action. It will be clear that each of the surfaces [fol. 267] or folds 5, of the diaphragm illustrated in Figs. 3 and 4 is in the same condition of molecular stress, as the sheet 5′ in Fig. 6.

The width of the folds 5, relative to the breadth of the strip in which they are made, may vary; but I have found a convenient proportion to adopt when making the diaphragm of paper is about 10 to 1, so that each fold of the strip is 10 times as long as wide.

I have found that in a diaphragm having multiple resilient surfaces such as that above described, a greatly improved reproduction can be obtained. Moreover, a diaphragm constructed in the manner above described can be usefully made of considerably greater diameter than has heretofore been possible. Experience has seemed to prove that a plane diaphragm of mica, or other material such as is used at the present day, if made of more than about three-and-a-half inches in diameter, loses in quality of reproduction, the reproduction becoming less musical and there being a liability to what there is technically known as "shattering," due probably to the diaphragm not vibrating as a whole, i. e., to the setting up of nodes in the diaphragm. I have found, however, that I am able to make a diaphragm according to the present invention, as large as ten inches or more in diameter, without impairing the quality of the reproduction, and by means of this diaphragm, I at the same time, attain a much greater volume of sound than with the smaller diaphragm. This amplification of the sound, I believe to be due, not only to the increased diameter of the diaphragm, but also to the increased surface area of the diaphragm produced in the construction above described, by the plaitings or crimpings or folds in the material of the diaphragm; this appears to have the effect of putting into motion a greater volume of air and so increasing the volume of sound.

A diaphragm having freely resilient sound responsive surfaces brought into a condition of molecular stress, preferably by torsion, and also of an aggregate area substantially larger than a plane disk of the same diameter may of course be produced in other ways than that above described. I have found, however, that the above described method is a convenient one for making the diaphragm.

The advantage arising from the use of a diaphragm constructed as above described, is that the volume of sound produced is sufficient to enable me to dispense with the usual amplifying horn, and in this way, much of the metallic and hollow character usually associated with talking machine reproductions is eliminated.

Diaphragms may be made according to this invention, of any suitable elastic material, such as paper, (which may be varnished if desired), card, celluloid, metal, or the like,

and the surface, or surfaces, of the diaphragm, or elements composing the vibrating body, may be put under tension by any suitable means.

One means of mounting the stylus bar and diaphragm in an operative position particularly for use with a record having a record of sound in the form of a groove having lateral undulations in the walls thereof is shown in Figs. 7 and 8. In this case, the diaphragm 4 is held at the edges by clamping rings 9 and 10, and, to the front ring 9, may be secured a small trumpet 11 for directing the sound waves. The clamping ring 10 is fixed to a suitable backing ring 12, having radial arms 13 by which the same is carried by a tube 14 which is capable of turning freely in the bearings 15—15, of the swinging arm 16, pivoted at 17 upon a rigid bracket 18, fixed to the cabinet 19. The cabinet 19 is provided with a suitable mechanism for rotating the turn-table 20 upon which a record 21 is carried in the usual manner.

The tube 14 is provided at one end with a mounting 22 freely rotatable upon said tube 14, but prevented in any suitable manner, from longitudinal movement upon the tube 14. This mounting 22 carries a stylus bar 23 which may be mounted thereon in any suitable manner, as by being pivoted on the knife edges 24, and retained on said knife edge bearings by a spring 25, in the usual manner. The upper end of the stylus bar 23 is connected by a rod 26 with the diaphragm 5, the rod 26 being connected or attached to the diaphragm by nuts 7 in the manner shown in Fig. 5. In this construction as shown in Figs. 7 and 8, the diaphragm is preferably made from a sheet of material such as is shown in Fig. 2 of the drawings so as to provide a suitable recess on each side of the diaphragm, in which the nuts 7 are seated. These nuts may be further cemented or otherwise secured to the diaphragm. In the said figures the diaphragm is also shown as being provided with a stiffening ring 8 at the center of the diaphragm and surrounding the stylus bar connection 26. Suitable nuts or collars 27 may be employed for holding the tube 14 from lengthwise movement in the bearings 15.

As the stylus 28 follows the record groove, the arm 16 will swing across the record on the pivot 17, and the mounting 22, carrying the stylus bar 23, will oscillate around the tube 14 with any unevenness in the rotation of the rec-

ord. A suitable weight 29 may be attached to the mounting 22, to cause the stylus to engage the record with the requisite amount of pressure.

In Figs. 9, 10 and 11, I have illustrated a further modifi- [fol. 268] cation of the way in which my diaphragm may be used in connection with a sound reproducing machine. In said figures, the record 21 is supported upon and rotated by a turn-table 20 driven by any suitable motor within the casing 19, and the cabinet is provided with a bracket 18 similar to the arrangement above described in connection with Figs. 7 and 8. An arm 30 is mounted upon a steam or pintle 31 to swing on said bracket in a plane substantially parallel with the plane of the record 21. The bracket 18 may be provided with a vertically adjustable step 32 for the end of the stem 31, which, in the form illustrated in Fig. 9, consists of a screw threaded into the bracket 18, and against which the end of the stem or pintle 31 rests. By this means, the arm 30 may be raised or lowered to adjust the parts carried thereby with respect to the record 21 on the turn-table 20, to set the stylus at the proper angle to the record surface. The free end of the arm 30 carries a yoke 33 pivoted to the said arm by a bolt or pin 34, so as to be capable of swinging in a plane substantially perpendicular to the plane of the record. The said arm 30 is provided with a stop 35, which prevents the yoke from swinging downwardly beyond a predetermined point. The outer ends of the yoke 33 are secured to lugs 36 bolted to the rings 37, 38, by bolts 39, passing through said rings and said lug. Screws 40, passing through the ends of the yoke 33 and into the lugs 36, from the pivots to permit the rings and the parts carried thereby, to oscillate thereon. The diaphragm 41 is of the kind which I have described above; that is to say, the diaphragm is formed by reversely folding a sheet of material to form plaits, each plait forming an element of the diaphragm, and each of these plaits or elements is subjected to a torsional tension or strain by the bringing of the folded or plaited sheet of material into a substantially circular form. In these Figs. 9 to 11, the diaphragm is shown practically as being formed from a sheet of material such as is shown in Fig. 2; that is to say, a strip in which each plait is cut away at its inner corners so as to form a recess on each side of the center of the dia-

phragm to permit of a convenient attachment of the stylus bar to the diaphragm. As is plainly shown in Fig. 10, the diaphragm 41 is clamped between the rings 37 and 38, and securely held in that position by means of the screws 42 passing through the said rings and drawing them together. I prefer however, to interpose, between the rings 37 and 38, and the diaphragm, thin rings 43—43 of a suitable non-metallic and preferably slightly elastic material, one on each side of the diaphragm. These rings 43, may be of fabric, or rubber, or fiber, or any other suitable material to prevent an actual contact between the diaphragm and the metallic rings 37 and 38, and to securely hold the periphery of the diaphragm in a single plane. A suitable small trumpet 11 may be also secured between the rings for the purpose of directing the sound waves. I have shown it plainly in Figs. 9 and 10 as composed of a slightly flaring substantially conical member having a flange 11′ clamped between the rings 37 and 38, the screws 22 passing therethrough. The periphery of the diaphragm 41 is clamped between the intermediate rings 43, and held thereby in a single plane as plainly shown in Fig. 10.

The bottom of the reproducer is provided with a suitable support for the stylus bar, said support comprising a bar 44 secured to the ring 38 by screws 45, or in any other suitable manner. The said bar 44 may carry a block 46 rigidly secured thereto and upon the lower side of said block, I mount the stylus bar. Any suitable mounting for the stylus bar may be employed, but in the said modification illustrated in Figs. 9 to 11, I have shown the block 46 as provided with a pair of alined knife edges 47 engaging suitable recesses and lateral extensions 48 of the stylus bar 49. Each lateral extension is provided with a spring 50, one end of which is attached to said extension 48, and the other end of which extends outwardly and is provided with a hole through which a screw 51 passes, the head of the screw engaging the end of said spring 50 and the screw being threaded in a suitable tapped plate 52 carried by the said block 46. In this way the stylus bar is yieldingly held upon the knife edges 47, but is free to oscillate upon them as bearings. The lower end of the stylus bar is provided with a suitable set screw 53 for securing the stylus 54 in the socket therein. The stylus bar 49 may have a portion

49′ extending at an angle to the stylus carr-ing portion and it may then extend upwardly as at 55 to this point of attachment to the center of the diaphragm. I have shown the said upwardly extending portion 55 as being curved in order to make it slightly yielding, and the point between the portions 49′ and 55 as being materially weakened to enable the stylus bar to readily bend or spring or give slightly at this point to transform the vibratory movement of the stylus into a reciprocatory movement of the portion 55 which is directly attached to and consequently communicates its motion to the center of the diaphragm.

In adjusting the reproducer to the recorded surface, the arm 30 should be set at such a height that the stylus will be given a slight rake to the recorded surface, as plainly shown in Fig. 9. This will permit the record to slide freely beneath the stylus without unduly scratching the same and cause the stylus to engage the record with [fol. 269] a sufficient pressure to insure the tracking of the stylus in the record groove. The record may then slide freely beneath the stylus, and the whole reproducer may swing slightly on the bolts or pins 40 to allow for any irregularity or unevenness or warp in the recorded surface.

In order that the stylus may not bear too heavily upon the record, the trumpet 11 may be provided with a suitable counterbalance-weight 59.

From the preceding description it will be plain that the whole construction is such that the trumpet, diaphragm, rings and stylus attached thereto may be swung upwardly about the bolts or pin 34 as a pivot for the purpose of replacing the stylus or for throwing the whole device into an inoperative position, as indicated in dotted lines in Fig. 9.

In operation it will be apparent that when the record is given a rotary movement from the turn-table 20 and the stylus 54 engages the record 21, the whole reproducer will swing about the stem or pintle 31 as a pivot allowing the needle or stylus 54 to track across the record and the stylus will be caused to assume the correct angle to the recorded surface by the adjustment of the step 32 against which the stem or pintle 31 abuts, and further, that the stylus will be prevented from bearing too heavily upon the record by the

counter-weight 59 attached to the upper end of the trumpet 11.

In all the forms which I have above described, it will be seen that the diaphragm is constructed upon the same principle, and that it is mounted in substantially the same manner, and that any suitable manner of securing the stylus to the center of the diaphragm may be employed, and while I have shown a small trumpet 11 in connection with the constructions which I have illustrated, it is to be understood that the trumpet may be entirely dispensed with if desired, the function being to give direction to the sound waves rather than to increase the volume of the sound reproduced by the diaphragm.

Having thus described my invention, what I claim and desire to protect by Letters Patent of the United States, is:

1. The method of making a diaphragm which consists in plaiting a strip of flexible material, joining the ends of the plaited material and bringing the same to a circular shape to form a diaphragm in which each of the plaits forms an element subjected to torsional tension.

2. The method of making a diaphragm which consists in plaiting a strip of flexible material, joining the ends of the plaited material and subjecting each of the plaits to a torsional tension.

3. The method of making a diaphragm which consists in reversely folding a strip of flexible material into a series of plaits, removing a corner of each of said strips, bringing the ends of said plaited material together and forming the same into a substantially circular shape having radial salient and reëntrant angles.

4. The method of making a diaphragm which consists in reversely folding a strip of flexible material, twisting the folded sheet into substantially circular shape and rigidly holding the edges of the diaphragm so formed in a single plane.

5. The method of forming a diaphragm, which consists in plaiting a substantially rectangular strip of material, removing a corner of each plait on one side of the strip, uniting the ends of the strip and forming the said material into a substantially circular diaphragm, each of the plaits forming an element of the diaphragm with its edge at the center of the diaphragm substantially parallel to the axis of the

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ACOUSTICAL INSTRUMENT.

APPLICATION FILED MAR. 26, 1910.

1,036,529.

Patented Aug. 20, 1912.

3 SHEETS—SHEET 1.

Fig. 1.

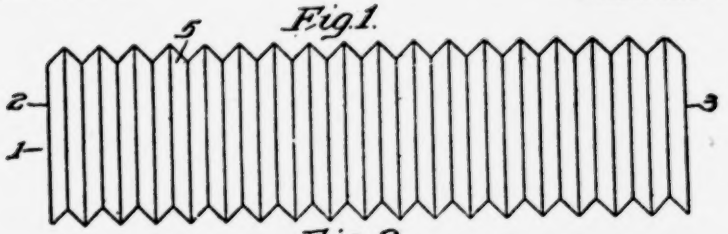


Fig. 2.

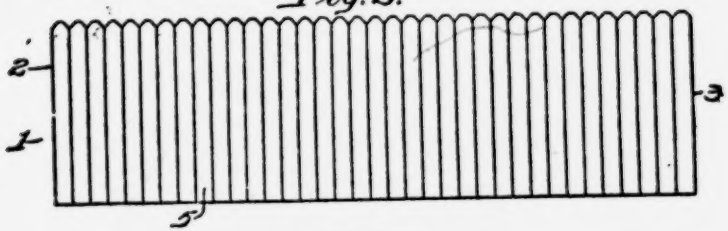


Fig. 3.

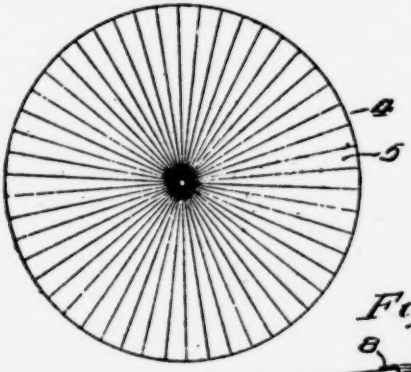


Fig. 4.

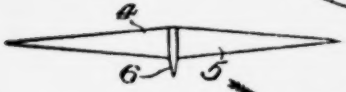
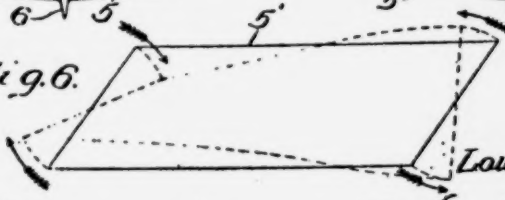


Fig. 5.

Fig. 6.



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5 SHEETS—SHEET 2.

Fig. 7.

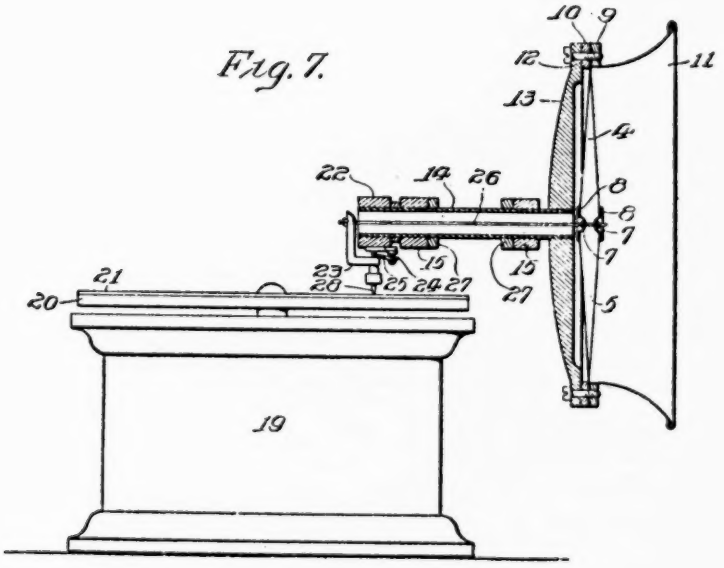
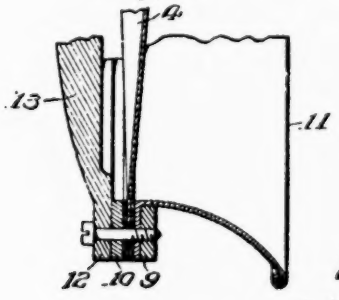


Fig. 7a



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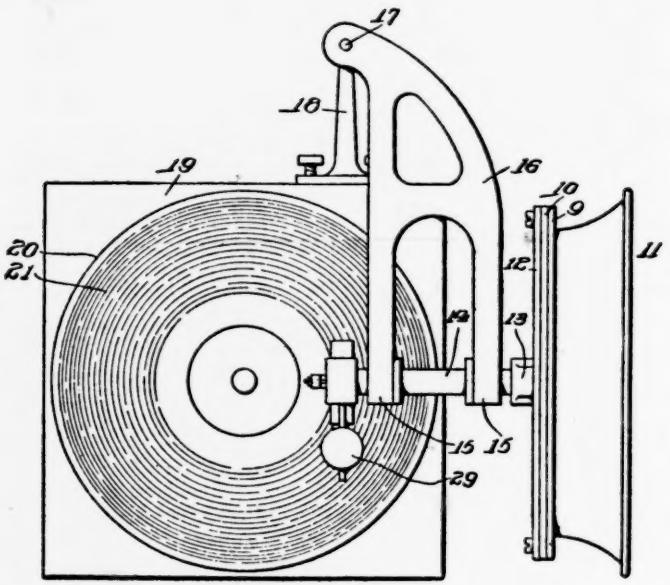
5 SHEETS—SHEET 3.

Fig. 8.



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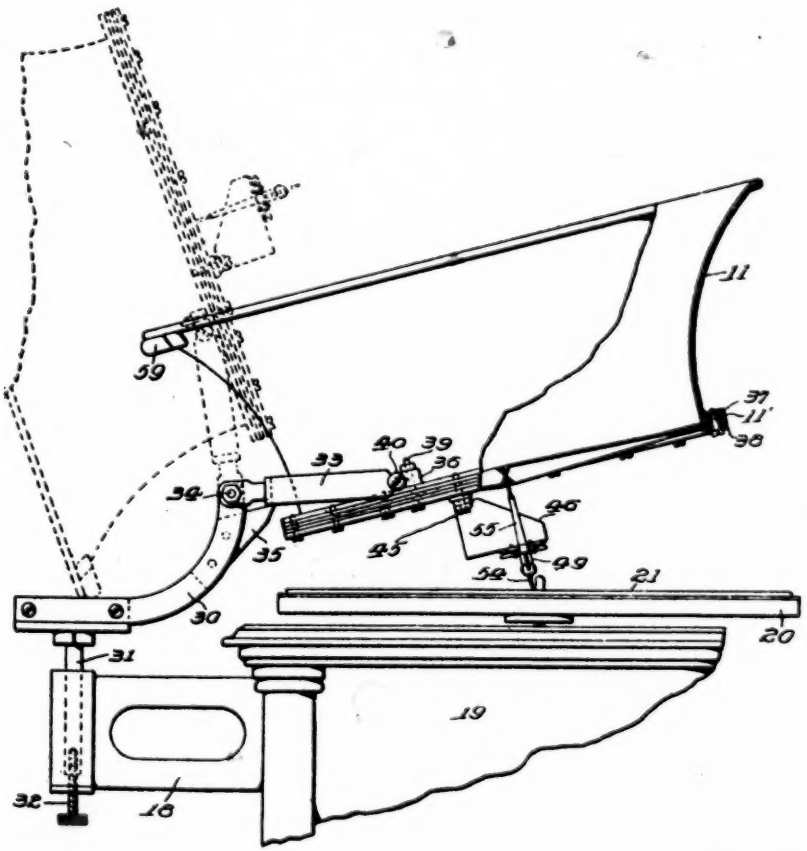
1,036,529.

Patented Aug. 20, 1912.

5 SHEETS—SHEET 4.

Fig. 9.



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5 SHEETS—SHEET 5.

Fig. 10.

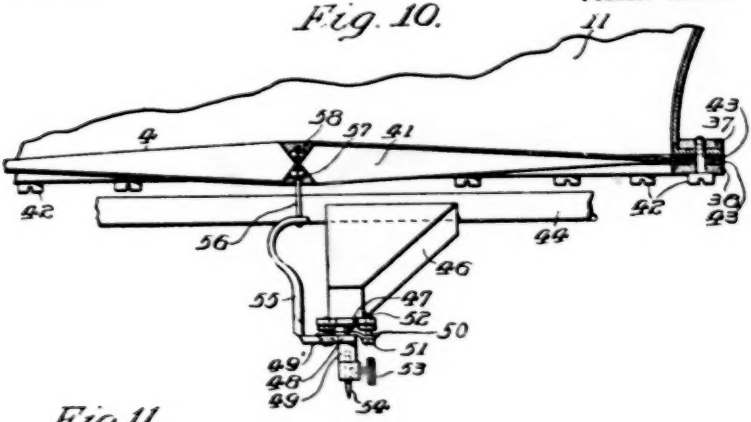
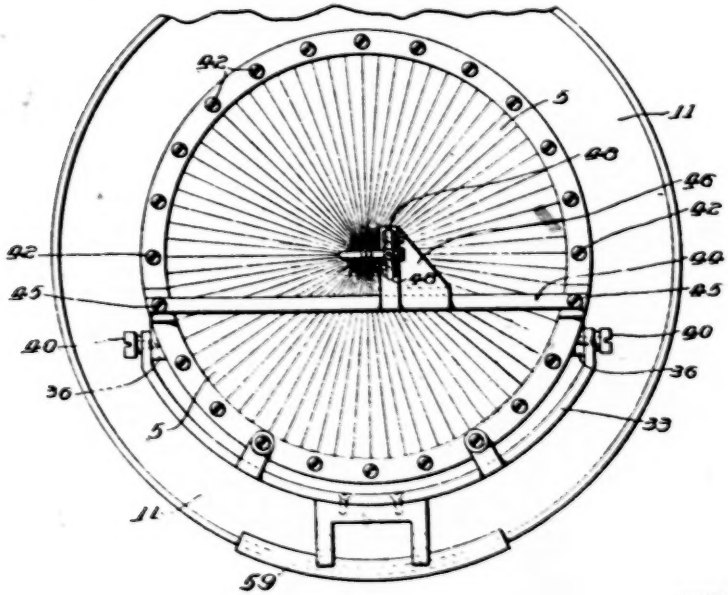


Fig. 11.



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diaphragm and the edge of each plait at the periphery of the diphragm being brought to substantially a single plane.

6. The method of forming a diaphragm, which consists in plaiting a substantially rectangular strip of material, uniting the ends of the strip and forming the said material into a substantially circular diaphragm, each of the plaits forming an element of the diaphragm with its edge at the center of the diaphragm substantially parallel to the axis of the diaphragm, the edge of each plait at the periphery of the diaphragm being brought to substantially a single plane, and securing an annular strip of stiffening to the edges of the elements adjacent the center of the diaphragm.

In witness whereof I have hereunto set my hand this fourth day of June, A. D. 1909.

Louis Lumiere.

Witnesses: L. N. Reddie, A. J. Cooley.

[fol.270] Corrections in Letters Patent No. 986,477

It is hereby certified that in Letters Patent No. 986,477, granted March 14, 1911, upon the application of Louis Lumiere, of Lyons, France, for an improvement in "Acoustical Instruments," errors appear in the printed specification requiring correction as follows: Page 4, line 9, the word "steam" should read *stem*, and same page, line 100, the word "suitable" should read *suitably;* and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 11th day of April, A. D., 1911.

C. C. Billings, Acting Commissioner of Patents.

(Seal.)

(Here follow drawings, side folios 271, 272, 273, 274, and 275)

[fol. 276] United States Patent Office

Louis Lumiere, of Lyons, France, Assignor to Victor Talking Machine Company, of Camden, New Jersey, a Corporation of New Jersey

Acoustical Instrument

Specificaton of Letters Patent

1,036,529. Patented Aug. 20, 1912

Original Application Filed June 30, 1909, Serial No. 505,149. Divided and This Application Filed March 26, 1910. Serial No. 551,638

To all whom it may concern:

Be it known that I, Louis Lumiere, a citizen of the Republic of France, residing at Lyons, in the Republic of France, have invented certain new and useful Improvements in Acoustical Instruments, of which the following is a full, clear, and complete disclosure.

This invention relates to improvements in acoustical instruments, such as telephones, microphones, sound recording and reproducing machines, and musical instruments in general, and the present application is a division of an application filed by me June 30, 1909, Serial Number 505,149.

As applied to sound recording and reproducing apparatus, my invention relates more particularly to that part of the instrument which is generally known as the diaphragm, or the body which in the process of sound recording is thrown into vibration by the sound waves, and the vibrations of which are traced and recorded by means of a stylus in the original record, while in the process of reproduction the diaphragm, (as a general rule, the diaphragm of a separate machine) is thrown into corresponding vibrations by a stylus to which it is attached, being made to follow the undulations in the record.

My invention also relates to the sound box in which said diaphragm is mounted.

The object of my invention is to provide a diaphragm and a mounting therefor, by means of which sounds may

be faithfully recorded and reproduced, which will be sensitive to sound waves and by the use of which the reproduction of sound will be improved and amplified.

Further objects of my invention are to increase the reproducing surface of a diaphragm, and, at the same time, to place the entire surface under a tension, (preferably torsional), to make it sensitive; to increase the active surface of a diaphragm of a certain given diameter; to increase the diameter of the diaphragm without making it liable to vibrate in parts, or to set up nodes or inactive portions in the diaphragm, or, in other words, to substantially increase the size of the diaphragm and, at the same time, have it vibrate throughout; to construct a diaphragm having a plurality of sound responsive elements, each of which is subjected to a molecular tension, and to subject each of a plurality of sound responsive elements to a molecular tension to increase the sensitiveness thereof and to cause them to vibrate as a whole.

Further objects of my invention will be found in the specification and claims below.

The invention consists in a diaphragm for acoustical instruments, having one or more freely resilient, sound responsive surfaces or elements, which have been brought into a condition of molecular stress, of an aggregate superficial area substantially larger than the surface of a plane disk of the same diameter, and in a recorder or reproducer in which said diaphragm is mounted.

It is found that the effect of bringing the surfaces of a vibrating body into a condition of molecular stress by torsion, is to reduce to a minimum the tendency of the vibrating body to form nodes during operation, so that the surface or surfaces of the diaphragm will vibrate as a whole and will not produce the disagreeable effect which is technically known as blasting or shattering.

One construction of diaphragm made according to this invention and the method of making it is illustrated in the accompanying drawings, in which:

Figure 1 shows a folded strip of material from which the improved diaphragm may be made; Fig. 2 is a plan view of a modified form of folded strip of material from which a diaphragm may be made; Fig. 3 is a plan view of the diaphragm; Fig. 4 is a sectional elevation of the dia-

phragm; Fig. 5 is a sectional elevational view of a slightly modified form of diaphragm; Fig. 6 is a diagram to illustrate the way in which the surfaces or elements of the diaphragm are twisted; Fig. 7 is an elevation of a sound reproducing machine fitted with the diaphragm made in accordance with this invention and illustrates a convenient method of carrying the diaphragm and connecting it to the stylus bar; and Fig. 7a is a sectional detail portion of Fig. 7. Fig. 8 is a plan view of the machine shown in Fig. 7; Fig. 9 is a side elevational view partly in section of a modified form of sound reproducing machine provided [fol. 277] with my invention. Fig. 10 is an enlarged view, partly in section, of the diaphragm and stylus bar mounting shown in Fig. 9; and Fig. 11 is a bottom plan view of the reproducer shown in Fig. 9.

According to one method of carrying out this invention, a diaphragm is constructed so that it represents the form shown in Figs. 1, 3 and 4 of the accompanying drawings, in which the whole surface of the diaphragm on either side consists of a plurality of elements reversely flexed to form a fan-like series of radially disposed ridges and furrows, the ridges on one side of the diaphragm corresponding to the furrows on the other side of the diaphragm, and the furrows gradually widening out and becoming less deep as they approach the edge of the diaphragm until at its perimeter the diaphragm lies in one plane. The elements forming the sides of the ridges and furrows provide the desired freely resilient sound responsive surfaces. A diaphragm of this form may be obtained by folding or plaiting a substantially rectangular strip of paper 1, or other suitable material in the manner shown in Fig. 1. The length of the strip of material before folding should be substantially the length of the circumference of the diaphragm to be formed therefrom, and the width of the strip should be substantially equal to the radius of the said diaphragm. When the strip has been plaited or folded in the manner above described and shown, the ends 2 and 3 should be brought together and secured to each other in any suitable manner. At this stage of the process or method, the strip will present, roughly speaking, the appearance of a cylinder having fluted sides. This strip of material is then pressed down and forced to assume the

form shown in Figs. 3 and 4, one edge of the strip being crimped together at the center, and the other edge forming the perimeter; the radical ridges and furrows, or plaits being closest together and of greatest depth at the center, and gradually opening out and flattening toward the edge where the diaphragm may be held in one plane between clamping rings, as shown in Figs. 7 to 11. In Fig. 3 the diaphragm is designated as 4 and the elements forming the plaits or ridges and furrows are designated by the numeral 5. The diaphragm 4 thus formed in the manner above described will be seen to have a surface formed wholly of a multiplicity of flexed sound responsive elements, reversely sloped or angled to each other, forming dihedral ridges. The surface of the diaphragm will consist of a surface comprising salient radial angled surfaces, and radial reëntrant angled surfaces. Any sector of the surface will have a fan-like formation. To the center of the diaphragm, is attached, in any suitable manner, the recording or reproducing stylus 6, as the case may be. As shown in Fig. 4, the diaphragm is for use with or for a record having an up and down, or vertical cut, since the diaphragm is directly provided with a stylus at its center. For making the attachment between the stylus and diaphragm, or between the connection between the stylus and the diaphragm, I prefer to bevel off the inner edge of the diaphragm as particularly shown in Figs. 2, 9 and 10. The stylus 6 may be secured directly to the inner edges of the elements of the diaphragm by being cemented or glued thereto in the manner shown in Fig. 4, or it may be secured in place by means of nuts 7 as will be more particularly described below, in connection with the form of apparatus shown in Figs. 5, 9 and 10. The stylus 6 may also be surrounded by rings of stiff paper 8, secured on either side of the diaphragm at the center thereof to give it additional rigidity at that point. I do not, however, limit myself to this form of connection. The effect of constructing the diaphragm in this manner, is that the whole diaphragm, i. e., the surface of each element of each ridge and furrow is under molecular stress, produced by torsion, but the sides of the ridges and furrows are twisted out of the plane in which they lie at the center of the diaphragm into a plane, practically at right angles thereto, at the circumference

of the diaphragm. I have further found that in a diaphragm produced by this means, the tendency of the vibrating body to form nodes during operation is reduced to a minimum. The surface of each of the elements composing this diaphragm being helicoidal, and since each point in the vibrating body, as it moves, follows a direction normal to the tangential plane at this point, the result is that the direction of movement is different for each point that has to be considered so that the formation of nodes is practically impossible. It is obvious, of course, that the same condition of molecular stress would be produced upon twisting a sheet of material which naturally possessed a helicoidal, or other than plane, form so as to take up a position in a true plane, or other helicoidal form of different pitch.

The diagram shown in Fig. 6, illustrates clearly the torsion which is applied to each of the multiple surfaces or elements of the diaphragm when the strip of material is made to take up the form shown in Figs. 3 and 4 from the form shown in Fig. 1. In this diagram 5′ represents a thin flat sheet of elastic material, such as is formed by each of the several folds or plaitings of the strip shown in Figs. 1 and 2. If the two ends of this sheet are turned in opposite directions, as indicated by the arrows, and is made to take up the position shown in dotted lines, it is found that a very resilient body is formed, which is capable [fol. 278] of vibrating more readily, and is more sensitive, i. e., more sound responsive in its new position than it was before. This is probably due to the molecular stress which is imparted to it by this twisting action.

It will be clear that each of the surfaces or folds 5, of the diaphragm illustrated in Figs. 3 and 4 is in the same condition of molecular stress, as the sheet 5′ in Fig. 6.

The width of the folds 5, relative to the breadth of the strip in which they are made, may vary; but I have found a convenient proportion to adopt when making the diaphragm of paper is about 10 to 1, so that each fold of the strip is 10 times as long as wide.

I have found that in a diaphragm having multiple resilient surfaces such as that above described, a greatly improved reproduction can be obtained. Moreover, a diaphragm constructed in the manner above described can be

usefully made of considerably greater diameter than has heretofore been possible. Experience has seemed to prove that a plane diaphragm of mica, or other material, such as is used at the present day, if made of more than about three-and-a-half inches in diameter, loses in quality of reproduction, the reproduction becoming less musical and there being a liability to what *there* is technically known as "shattering" due probably to the diaphragm not vibrating as a whole, i. e., to the setting up of nodes in the diaphragm. I have found, however, that I am able to make a diaphragm according to the present invention, as large as ten inches or more in diameter, without impairing the quality of the reproduction, and by means of this diaphragm, I at the same time, attain a much greater volume of sound than with the smaller diaphragm. This amplification of the sound, I believe to be due, not only to the increased diameter of the diaphragm, but also to the increased surface area of the diaphragm produced in the construction above described, by the plaitings or crimpings or folds in the material of the diaphragm; this appears to have the effect of putting into motion a greater volume of air and so increasing the volume of sound.

A diaphragm having freely resilient sound responsive surfaces brought into a condition of molecular stress, preferably by torsion, and also of an aggregate area substantially larger than a plane disk of the same diameter may of course be produced in other ways than that above described. I have found, however, that the above described method is a convenient one for making the diaphragm.

The advantage arising from the use of a diaphragm constructed as above described, is that the volume of sound produced is sufficient to enable me to dispense with the usual amplifying horn, and in this way, much of the metallic and hollow character usually associated with talking machine reproductions is eliminated.

Diaphragms may be made according to this invention, of any suitable elastic material, such as paper, (which may be varnished if desired), card, celluloid, metal, or the like, and the surface, or surfaces, of the diaphragm, or elements composing the vibrating body, may be put under tension by any suitable means.

One means of mounting the stylus bar and diaphragm in an operative position particularly for use with a record having a record of sound in the form of a groove having lateral undulations in the walls thereof is shown in Figs. 7 and 8. In this case, the diaphragm 4 is held at the edges by clamping rings 9 and 10, and, to the front ring 9, may be secured a small trumpet 11 for directing the sound waves. The clamping ring 10 is fixed to a suitable backing ring 12, having radial arms 13 by which the same is carried by a tube 14 which is capable of turning freely in the bearings 15—15, of the swinging arm 16, pivoted at 17 upon a rigid bracket 18, fixed to the cabinet 19. The cabinet 19 is provided with a suitable mechanism for rotating the turntable 20 upon which a record 21 is carried in the usual manner. The tube 14 is provided at one end with a mounting 22 freely rotatable upon said tube 14, but prevented in any suitable manner, from longitudinal movement upon the tube 14. This mounting 22 carries a stylus bar 23 which may be mounted thereon in any suitable manner, as by being pivoted on the knife edges 24, and retained on said knife edge bearings by a spring 25, in the usual manner. The upper end of the stylus bar 23 is connected by a rod 26 with the diaphragm 5, the rod 26 being connected or attached to the diaphragm by nuts 7 in the manner shown in Fig. 5. In this construction as shown in Figs. 7 and 8, the diaphragm is preferably made from a sheet of material such as is shown in Fig. 2 of the drawings so as to provide a suitable recess on each side of the diaphragm, in which the nuts 7 are seated. These nuts may be further cemented or otherwise secured to the diaphragm. In the said figures the diaphragm is also shown as being provided with a stiffening ring 8 at the center of the diaphragm and surrounding the stylus bar connection 26. Suitable nuts or collars 27 may be employed for holding the tube 14 from lengthwise movement in the bearings 15.

As the stylus 28 follows the record groove, the arm 16 will swing across the record on the pivot 17, and the mounting 22 carrying the stylus bar 23, will oscillate around the [fol. 279] tube 14 with any unevenness in the rotation of the record. A suitable weight 29 may be attached to the

mounting 22, to cause the stylus to engage the record with the requisite amount of pressure.

In Figs. 9, 10 and 11, I have illustrated a further modification of the way in which my diaphragm may be used in connection with a sound reproducing machine. In said figures, the record 21 is supported upon and rotated by a turn-table 20 driven by any suitable motor within the casing 19, and the cabinet is provided with a bracket 18 similar to the arrangement above described in connection with Figs. 7 and 8. An arm 30 is mounted upon a stem or pintle 31 to swing on said bracket in a plane substantially parallel with the plane of the record 21. The bracket 18 may be provided with a vertically adjustable stop 32 for the end of the stem 31, which, in the form illustrated in Fig. 9, consists of a screw threaded into the bracket 18, and against which the end of the stem or pintle 31 rests. By this means, the arm 30 may be raised or lowered to adjust the parts carried thereby with respect to the record 21 on the turn-table 20, to set the stylus at the proper angle to the record surface. The free end of the arm 30 carries a yoke 33 pivoted to the said arm by a bolt or pin 34, so as to be capable of swinging in a plane substantially perpendicular to the plane of the record. The said arm 30 is provided with a stop 35, which prevents the yoke from swinging downwardly beyond a predetermined point. The outer ends of the yoke 33 are secured to lugs 36 bolted to the rings 37, 38, by bolts 39, passing through said rings and said lug. Screws 40, passing through the ends of the yoke 33 and into the lugs 36, form the pivots to permit the rings and the parts carried thereby, to oscillate thereon. The diaphragm 41 is of the kind which I have described above; that is to say, the diaphragm is formed by reversely folding a sheet of material to form plaits, each plait forming an element of the diaphragm, and each of these plaits or elements is subjected to a torsional tension or strain by the bringing of the folded or plaited sheet of material into a substantially circular form. In these Figs. 9 to 11, the diaphragm is shown practically as being formed from a sheet of material such as is shown in Fig. 2; that is to say, a strip in which each plait is cut away at its inner corners so as to form a recess on each side of the center of the diaphragm to permit of a convenient attachment of the stylus bar to the diaphragm.

As is plainly shown in Fig. 10, the diaphragm 41 is clamped between the rings 37 and 38, and securely held in that position by means of the screws 42 passing through the said rings and drawing them together. I prefer, however, to interpose, between the rings 37 and 38, and the diaphragm, thin rings 43—43 of a suitable non-metallic and preferably slightly elastic material, one on each side of the diaphragm. These rings 43, may be of fabric, or rubber, or fiber, or any other suitable material to prevent an actual contact between the diaphragm and the metallic rings 37 and 38, and to securely hold the periphery of the diaphragm in a single plane. A suitable small trumpet 11, may be also secured between the rings for the purpose of directing the sound waves. I have shown it plainly in Figs. 9 and 10 as composed of a slightly flaring substantially conical member having a flange 11′ clamped between the rings 37 and 38, the screws 42 passing therethrough. The periphery of the diaphragm 41 is clamped between the intermediate rings 43, and held thereby in a single plane as plainly shown in Fig. 10.

The bottom of the reproducer is provided with a suitable support for the stylus bar, said support comprising a bar 44 secured to the ring 38 by screws 45, or in any other suitable manner. The said bar 44 may carry a block 46 rigidly secured thereto and upon the lower side of said block, I mount the stylus bar. Any suitable mounting for the stylus bar may be employed, but in the said modification illustrated in Figs. 9 to 11, I have shown the block 46 as provided with a pair of alined knife edges 47 engaging suitable recesses and lateral extensions 48 of the stylus bar 49. Each lateral extension is provided with a spring 50, one end of which is attached to said extension 48, and the other end of which extends outwardly and is provided with a hole through which a screw 51 passes, the head of the screw engaging the end of said spring 50 and the screw being threaded in a suitably tapped plate 52 carried by the said block 46. In this way the stylus bar is yieldingly held upon the knife edges 47, but is free to oscillate upon them as bearings.

The lower end of the stylus bar is provided with a suitable set screw 53 for securing the stylus 54 in the socket therein. The stylus bar 49 may have a portion 49′ extend-

ing at an angle to the stylus carrying portion and it may then extend upwardly as at 55 to the point of attachment to the center of the diaphragm. I have shown the said upwardly extending portion 55 as being curved in order to make it slightly yielding, and the point between the portions 49′ and 55 as being materially weakened to enable the stylus bar to readily bend or spring or give slightly at this point to transform the vibratory movement of the stylus into a reciprocatory movement of the portion 55 which is directly attached to and consequently communicates its motion to the center of the diaphragm.

In adjusting the reproducer to the recorded surface, the [fol. 280] arm 30 should be set at such a height that the stylus will be given a slight rake to the recorded surface, as plainly shown in Fig. 9. This will permit the record to slide freely beneath the stylus without unduly scratching the same and cause the stylus to engage the record with a sufficient pressure to insure the tracking of the stylus in the record groove. The record may then slide freely beneath the stylus, and the whole reproducer may swing slightly on the bolts or pins 40 to allow for any irregularity or unevenness or warp in the recorded surface.

In order that the stylus may not bear too heavily upon the record, the trumpet 11 may be provided with a suitable counterbalance-weight 59.

From the preceding description it will be plain that the whole construction is such that the trumpet, diaphragm, rings and stylus attached thereto may be swung upwardly about the bolts or pin 34 as a pivot for the purpose of replacing the stylus or for throwing the whole device into an inoperative position, as indicated in dotted lines in Fig. 9.

In operation it will be apparent that when the record is given a rotary movement from the turn-table 20 and the stylus 54 engages the record 21, the whole reproducer will swing about the stem or pintle 31 as a pivot allowing the needle or stylus 54 to track across the record and the stylus will be caused to assume the correct angle to the recorded surface by the adjustment of the step 32 against which the stem or pintle 31 abuts, and further, that the stylus will be prevented from bearing too heavily upon the record by the counter-weight 59 attached to the upper end of the trumpet 11.

In all the forms which I have above described, it will be seen that the diaphragm is constructed upon the same principle, and that it is mounted in substantially the same way, and that any suitable manner of securing the stylus to the center of the diaphragm may be employed, and while I have shown a small trumpet 11 in connection with the constructions which I have illustrated, it is to be understood that the trumpet may be entirely dispensed with if desired, the function being to give direction to the sound waves rather than to increase the volume of the sound reproduced by the diaphragm.

Having thus described my invention, what I claim and desire to protect by Letters Patent of the United States, is:—

1. A phonic diaphragm having a plurality of reversely flexed sound-responsive elements, each of said elements being held distorted from a normal shape under a torsional stress and tending to return to said normal shape.

2. In a sound box, the combination of a diaphragm composed of a plurality of radial sound-responsive elements, tending to assume a position coincident with a plane surface, and means to hold said elements in a flexed position.

3. A phonic diaphragm having a plurality of radial flexed sound-responsive elements, each element held under a torsional stress due to its flexed condition and tending to return to an unflexed condition.

4. A phonic diaphragm, having its entire surface composed of adjacent like elements arranged to form both salient and reëntrant angles, said angles forming alternate radial ridges and grooves, each of said elements being held distorted from a normal condition by a torsional stress and tending to return to said normal condition.

5. In a sound box, the combination of a diaphragm, having a plurality of radial sound-responsive elements tending to assume a position coincident with a plane surface, and means to hold said elements in a flexed position, with the outer ends of said flexed elements in a single plane.

6. A phonic diaphragm, having a plurality of sound-responsive elements, the angle between adjacent pairs of which progressively varies.

7. A phonic diaphragm including a plurality of like elements, each element being arranged between and inclined with respect to adjacent elements, each element being held

under a torsional stress, and said elements tending to assume positions coincident with a common plane.

8. A phonic diaphragm, comprising a plurality of helical sound-responsive elements, which tend to form a common plane surface.

9. A phonic diaphragm, having a plurality of torsioned elements radially disposed, said elements tending to assume positions coincident with a common plane.

10. A circular phonic diaphragm, having a plurality of elements, the slope of which transverse to the radius varies continuously from a maximum at the center of the diaphragm to a minimum at the periphery.

11. A phonic diaphragm, having a plurality of elements of transverse slope, varying progressively along a radius.

12. A phonic diaphragm, having a plurality of like torsioned elements which tend to return to a normal configuration.

13. A phonic diaphragm, formed of a plurality of sound-responsive elements, each of which is distorted under tension intermediate of its peripheral portions by the relationship of adjacent elements, and positive means for restraining the peripheral portions, said elements tending to return to a normal configuration.

14. In a sound recording or reproducing machine, a diaphragm composed of a plurality of elements, each of which [fol. 281] is normally subjected to torsional stress while in inoperative position, a stylus operatively connected to said diaphragm, and means to hold the edges of said diaphragm in substantially a single plane.

15. In a sound recorder or reproducer, a diaphragm composed of a plurality of elements, each of which is subjected to a torsional stress, the inner edge of each element being substantially parallel to the axis of the diaphragm.

16. In a sound recorder or reproducer, a diaphragm composed of a plurality of elements, each of which is subjected to a torsional stress, the inner edge of each element being substantially parallel to the axis of the diaphragm, and the corners of each element at the center of the diaphragm being beveled to form a recess at the center of the diaphragm.

17. In a sound recorder or reproducer, a diaphragm composed of a plurality of elements radially arranged, the inner edge of each element being substantially parallel to

the axis of the diaphragm, and the outer edge of each element being substantially in a plane normal to the axis of said diaphragm.

18. In a sound recorder or reproducer, a diaphragm composed of a plurality of elements, the inner edge of each element being substantially parallel to the axis of the diaphragm, and means to hold the outer edge of each element in a single plane.

19. In a sound recorder or reproducer, a diaphragm composed of a plurality of helical elements radiating from the center of the diaphragm, and a stiffening ring secured to the outside edges of said elements.

20. In a sound recorder or reproducer, a diaphragm composed of a plurality of elements, each of which is distorted by a torsional stress and tends to return to a normal configuration, and clamping rings on each side of the peripheral edge of the diaphragm holding said edge in a single plane.

21. A phonic diaphragm comprising a body portion of substantially uniform thickness of material and arranged substantially in the form of a double cone.

22. A phonic diaphragm, comprising a body portion consisting of a single thickness of material and arranged substantially in the form of a double cone, having a substantially flat flexible rim and oppositely disposed radial plaits, tapering outwardly in depth from the center of said body portion.

23. A phonic diaphragm comprising a body portion consisting of a single thickness of material, having a substantially circular rim arranged in a single plane, said body portion being provided with radial plaits tapering outwardly in depth from the central portion of the diaphragm, said plaits having their alternate angles upon opposite sides of said plane and arranged in substantially balanced or symmetrical relationship thereto.

24. The combination with a phonic diaphragm of means normally holding said diaphragm, when in inoperative position, under a torsional stress.

25. A phonic diaphragm having a portion normally held, when in inoperative position, under a torsional stress and tending to return to its original state.

26. In a sound box, the combination with an annular support, of a diaphragm carried thereby, a bar secured to opposite portions of said support, a block rigidly secured to said bar, a stylus bar phonetically connected to said diaphragm and provided with oppositely disposed lateral extensions, alined knife edges between said extensions and said block and yielding means for holding said bar in position with respect to said block.

27. In a sound box, the combination with an annular support, of a diaphragm carried thereby, a bar secured to opposite portions of said support, a block rigidly secured to said bar, a stylus bar phonetically connected to said diaphragm and provided with oppositely disposed lateral extensions, alined knife edges between said extensions and said block, and yielding means for holding said bar in position with respect to said block, said yielding means comprising a spring between each of said extensions and said block.

28. In a sound box, the combination with a diaphragm, of a stylus bar comprising an inner portion phonetically connected to said diaphragm, and a comparatively rigid outer portion mounted to oscillate about a fixed axis and forming a continuation of, and extending substantially at a right angle with, said inner portion, said bar having a flexible reduced portion connecting and forming a hinge between said inner and outer portions at the vertex of said angle, and the oscillation of said outer portion producing a longitudinal reciprocation of said inner portion, said flexible portions being connected only to said inner and outer portions.

29. In a sound box, the combination with a diaphragm, of a stylus bar comprising an inner portion phonetically connected to said diaphragm, and a comparatively rigid outer portion mounted to oscillate about a fixed axis and forming a continuation of, and extending substantially at a right angle to, said inner portion, said bar having a flexible reduced portion connecting and forming a hinge between said inner and outer portions at the vertex of said angle, and the oscillation of said outer portion producing a longitudinal reciprocation of said inner portion, and said inner portion being partly in the form of a yielding loop to permit the effective length of said inner portion to be varied

[fol. 282] slightly by the oscillation of said outer portion, said flexible portions being connected only to said inner and outer portions.

30. In a sound box, the combination with a support, of a diaphragm carried thereby, and a stylus bar, said stylus bar including a comparatively rigid portion mounted to oscillate on said support, and a connecting portion between said first mentioned portion and said diaphragm, said portions being joined by a flexible reduced portion forming a hinge between and connected only to said first mentioned portions and the oscillation of said first mentioned portion resulting in the longitudinal reciprocation of said connecting portion.

31. A phonic diaphragm having a portion normally distorted under a twisting stress while in an inoperative position, and tending to return to its original form.

In witness whereof I have hereunto set my hand this 11th day of March, A. D. 1910.

Louis Lumiere.

Witnesses: Paul H. Cram, Septimus Bracher.

(Here follows drawing, side folio 283)

[fol. 284] United States Patent Office

John C. English, of Camden, New Jersey, Assignor to Victor Talking Machine Company, a Corporation of New Jersey

Sound-Box for Talking-Machines

Specification of Letters Patent

1,064,062. Patented June 10, 1913

Application filed October 31, 1910. Serial No. 589,845

To all whom it may concern:

Be it known that I, John C. English, a citizen of the United States, and a resident of the city of Camden, county of Camden, and State of New Jersey, have invented certain

J. C. ENGLISH.

SOUND BOX FOR TALKING MACHINES.

APPLICATION FILED OCT. 31, 1910.

1,064,062. Patented June 10, 1913.

Fig. 1.

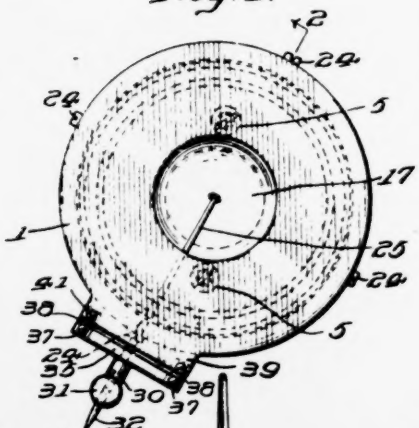

Fig. 2.

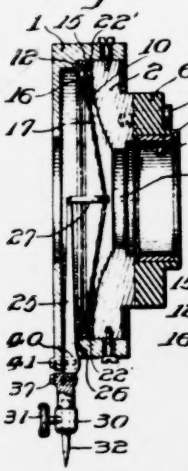

Fig. 4.

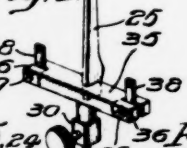

Fig. 3.

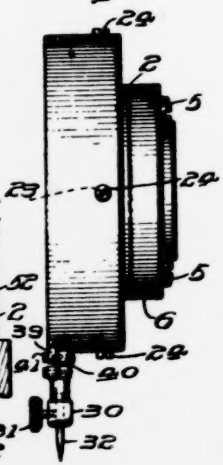

Fig. 5.

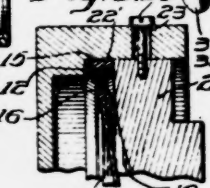

Fig. 6.

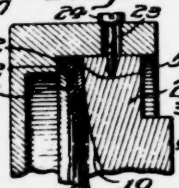

Fig. 7.

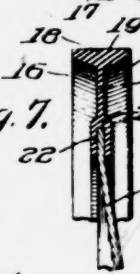

Fig. 8.

WITNESSES

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new and useful Improvements in Sound-Boxes for Talking-Machines, of which the following is a full, clear, and exact disclosure.

The main objects of this invention are, to provide an improved sound box of simple, compact and durable construction that will record and reproduce sounds with great accuracy and efficiency; to provide in a sound box, an improved casing, an improved diaphragm, and an improved stylus bar and mounting therefor; and to provide other improvements as will appear hereinafter.

It has been contended that in sound boxes in which a thin flexible diaphragm is used and in which the sound vibrations are produced or recorded by flexing the diaphragm, the diaphragm acts like a reed and responds sympathetically to certain tones in a manner that produces undesirable results. It has also been contended that such a diaphragm is comparatively difficult to vibrate and does not act with sufficient sensitiveness to produce or to record delicate over-tones. In this invention these defects which it has been contended are incident to the recording or reproduction of sound by the flexing of a diaphragm, are obviated by utilizing instead of a flexible diaphragm a light substantially inflexible diaphragm and an improved mounting therefor whereby the diaphragm is permitted to vibrate as a whole without being flexed.

In the accompanying drawings, Figure 1 is a front elevation of a sound box constructed in accordance with this invention; Fig. 2 a transverse section on the line 2—2 of Fig. 1; Fig. 3 a side elevation of the same; Fig. 4 a perspective of a detail of the same; Fig. 5 a fragmentary enlargement of a portion of Fig. 2; Fig. 6 a view similar to Fig. 5 but showing a modified form of this invention; Fig. 7 an enlarged fragmentary diametrical section of the diaphragm and mounting or supporting ring shown in Figs. 1, 2 and 5 as they appear before being placed in position in the sound box; and Fig. 8 is a view similar to Fig. 7, showing in a similar way the diaphragm and modified form of mounting therefor which are shown in operative position in Fig. 6.

Referring to the drawings, one embodiment of this invention comprises a cylindrical sound box casing or support composed of two main portions,—a cylindrical cup

shaped front plate 1 and a back plate 2 telescoping into the front plate and provided with a circular central aperture 3 for the passage of sound waves.

Secured to the rear face of the back plate 2, coaxial therewith, by means of screw 5, is a yielding tubular extension 6 provided with a non-yielding lining 7 and an inwardly projecting stop 8, whereby the sound box may be telescoped over the usual tubular tone-arm or sound conveyor (not shown).

The inner surface 10 of the back plate 2 is preferably convexly curved flaring inwardly from the central aperture 3 to the outer periphery of the plate. The inner surface of the front plate 1 of the casing is preferably in the form of a stepped cylinder, providing an annular shoulder 12 facing rearwardly and spaced from the opposite inner surface of the back plate 2, forming therewith an annular recess 15 in which snugly fits a yielding gasket or mounting 16, in which is supported a diaphragm 17.

The gasket 16 is continuous or closed in structure, is preferably made of rubber or other suitable solid resilient or yielding material, and is preferably substantially T-shaped in cross section, comprising a base 18 substantially equal in width to the width of the recess 15, and having a cylindrical outer surface 19 slightly greater in diameter than the cylindrical inner surface of the recess 15. The inner surface of the base 18 is preferably convex in cross section and in the form of two oppositely disposed inwardly converging conical surfaces 20, which meet in a centrally arranged normally flat annular web 21 which forms a reduced intermediate portion of the gasket. This web 21 is integral with the base 18 and extremely thin and flexible. The inner portion of the web 21 terminates in an annular binder or holder integral with and thicker than the web [fol. 285] and is provided upon its inner edge with a centrally arranged annular cylindrical grooved recess 22, in which snugly fits the marginal portion of the diaphragm 17. The gasket may be held in position by means of wax 22′ or other similar material applied between the base of the gasket and the inner cylindrical surface of the front plate 1.

The diaphragm 17 is preferably made of paper or any other light material, and when made of paper or other

similar porous material may be impregnated with resin or any other substance or composition to make the diaphragm moisture-proof. The diaphragm is of substantially uniform thickness throughout its entire extent, and with the exception of its marginal portion, is preferably dished or conical in shape, converging rearwardly axially with the sound box casing. The marginal portion of the diaphragm is preferably in the form of a flat annulus, arranged in a plane perpendicular to the longitudinal axis of the sound box.

As the diameter of the gasket 16 is silghtly larger than the internal diameter of the recess 15, in which it is held, the gasket will be held under a state of compression when the diaphragm and gasket are in operative position in the casing, and the thin portion of the web 21 will be slightly distorted laterally, as shown in Fig 2 and enlarged in Fig. 5, from its normally flat condition. The diaphragm is thus held when in operative position under a slight tension or compression against the periphery 17' thereof by the gasket acting radially against the peripheral edge of the diaphragm and it may here be stated that so far as this application is concerned the expressions "periphery" or "peripheral portion" or "peripheral edge" refer to the outer edge of the diaphragm, that is to say, that portion of the diaphragm between the plane surfaces of the opposite sides of the marginal portion of the diaphragm.

To hold the back plate 2 in position and to permit of the adjustment of the back plate toward and away from the gasket 16, a series of oblong apertures 23 are provided through the cylindrical rim of the front plate, and a headed screw 24 extends loosely through each of these apertures and is threaded into the back plate. By this construction the pressing of the back upon the base of the gasket may be varied to increase or diminish the pressure of the gasket against the peripheral edge of the diaphragm.

For communicating vibrations corresponding to sound waves to or from the diaphragm, a stylus bar 25 is mounted to oscilate upon the front plate of the sound box casing, one end of the bar being within the casing axially in front of the diaphragm, and the bar extending radially outwardly through an aperture 26 provided therefor in the casing. The inner end of the stylus bar is pivotally connected to

the outer end of a light but rigid connecting rod 27, the inner end of which is phonetically connected in any suitable manner to the central portion of the diaphragm, the outer end of the connecting rod being perferably bifurcated to receive the inner end of the stylus bar. The outer end of the stylus bar projects outwardly from the sound box casing and is provided with the usual stylus socket 30 and set screw 31 for holding a stylus 32 in place.

For supporting the stylus bar to oscilate upon a substantially fixed axis with respect to the sound box casing, the bar is provided outside of the casing with a cross-piece 35, rigid therewith, and projecting in opposite directions therefrom. Each end of this cross-piece 35 is recessed to receive a clamping plate 36, which is adjustably connected to the cross-piece by means of a headed screw 37, which extends loosely through the clamping plate and on aperture in one end of a flexible connector 38 and is threaded into the cross-piece 35.

Each of the two flexible connectors, or spaced yielding supports 38 is preferably made of thin tempered steel, but may be made of copper, fabric or other non-resilient material. Each connector 38 extends inwardly from the cross-piece 35, being clamped rigidly at its outer end between the cross-piece 35 and the clamping plates 36 by means of the screw 37. The inner end of each flexible connector 38 is similarly clamped against the rear surface of an extension 39, integral or rigid with the front portion of the sound box casing, by means of a clamping plate 40 and a screw 41. The flexible connectors 38 are thus arranged parallel to each other and in a plane substantially perpendicular to the longitudinal axis of the sound box casing.

The space between the extension 39 of the casing and the cross-piece 35 of the stylus bar is preferably only sufficient to permit of the necessary oscillation of the bar, and the bar is thus restrained to swing upon a substantially fixed axis, perpendicular to the bar and parallel to the plane of the marginal portion of the diaphragm.

In the modified form of this invention shown in Figs. 6 and 8, the sound box casing and the diaphragm 17 are constructed as hereinbefore described and the gasket 51 is substantially identically with the gasket 16, hereinbefore described except that the marginal portion or base of this

gasket is bifurcated and in the form of two outwardly diverging portions 52. The outer diameter of the bifurcated base of this gasket is normally substantially the same as [fol. 286] the inner diameter of the annular groove 15 in which it rests.

When the gasket 51 in its operative position the free edges of the two portions 52 of the base of the gasket are clamped toward each other between the shoulder 12 of the front plate 1 and the inner surface of the back plate 2, so as to compress the gasket radially against the peripheral edge of the diaphragm 17. The thin web-like portion of the gasket is slightly distorted laterally from its normally flat plane by this compression.

The stylus bar and its mounting and other features of this modified construction may be the same as shown and hereinbefore described.

In the operation of this device, owing to the extreme thinness and flexible nature of the web forming the intermediate portion of the gasket, and to the extreme lightness and comparatively inflexible nature of the diaphragm, the diaphragm is extremely sensitive to respond to the vibration of the stylus bar in reproducing sound or to respond to the action of the sound waves in recording sound and in either case therefore the diaphragm vibrates as a whole without any appreciable flexing and there is very little, if any, appreciable loss of efficiency due to the diaphragm or its mounting.

It is evident that in applying this invention various changes might be made in the constructions without departing from the spirit of this invention or the scope of the appended claims.

Having thus described this invention, I claim and desire to protect by Letters Patent of the United States:

1. In a sound box, the combination with a substantially inflexible conical diaphragm, of a yielding gasket supporting said diaphragm, said gasket being held under an initial pressure forcing said gasket against the peripheral edge of said diaphragm.

2. In a sound box, the combination with a circular diaphragm, of a yielding gasket supporting the same, said gasket comprising an annular base portion greater in internal diameter than the diameter of said diaphragm and

surrounding said diaphragm in the plane of the marginal edge thereof, and comprising a relatively thin annular portion between said base portion and said diaphragm.

3. A gasket for a sound box comprising an annular base portion, and a relatively thin normally flat annular portion carried by said base portion and projecting toward the center of said base portion from the internal surface of said base portion.

4. A yielding gasket for a sound box, comprising a base portion, a relatively thin portion inclosed by and projecting inwardly from said base portion, and a holder extending inwardly from said relatively thin portion, and adapted to support the marginal portion of a diaphragm.

5. An annular yielding gasket for a sound box, comprising a base portion, a relatively thin portion projecting inwardly from said base portion, and a grooved holder extending inwardly from said relatively thin portion, and adapted to support the marginal portion of a diaphragm.

6. In a sound box, the combination with a diaphragm, of yielding means engaging the peripheral edge of said diaphragm, and adjustable means for compressing said yielding means to apply a yielding pressure upon said peripheral edge radially with respect to said diaphragm.

7. In a sound box, the combination with a yielding support, of a diaphragm having its marginal edge surrounded and engaged by said support, the diaphragm being of a size to place the yielding support under initial compression, and adjustable means acting on the yielding support to modify the state of compression of said support.

8. In a sound box, the combination with a diaphragm having a cupped central portion and a substantially flat rim, of yielding gasket engaging said rim and held under an initial pressure, forcing said gasket radially against the peripheral edge of said rim.

9. In a sound box, the combination with a diaphragm, of a yielding gasket supporting said diaphragm, and bearing against the marginal edge thereof, said gasket comprising a yielding base portion having an internal diameter greater than the external diameter of said diaphragm and arranged in the plane of the marginal edge of said diaphragm, and comprising a relatively thin yielding portion between said base portion and said diaphragm.

10. An annular yielding gasket for a sound box, said gasket comprising a yielding annular base portion, and a yielding annular portion thinner than and inclosed by said base portion, integral therewith and projecting inwardly from the internal surface of said base portion.

11. An annular yielding gasket for a sound box, comprising a yielding annular base portion, a normally flat annular web thinner than said base portion and integral with and projecting inwardly therefrom and an internally grooved holder projecting inwardly from said web and integral therewith.

12. In a sound box, the combination with a diaphragm of a gasket surrounding said diaphragm and supporting the same, said gasket comprising a holder embracing the [fol. 287] opposite sides of the margin of said diaphragm, having a relatively thin web-like yielding portion integral with said holder and surrounding the same.

13. In a sound box, the combination with a diaphragm of a gasket surrounding said diaphragm and supporting the same, said gasket comprising a holder embracing the opposite sides of the margin of said diaphragm, having a relatively thin web-like yielding portion integral with said holder and surrounding the same, said gasket being in contact with the marginal edge of said diaphragm.

14. In a sound box, the combination with a diaphragm vibratory as a whole without flexing, and in a direction transverse to its own plane of a yielding gasket surrounding and supporting said diaphragm, said gasket being free to flex, and being held under an initial state of compression by said diaphragm.

15. In a sound box, the combination with a diaphragm vibratory as a whole, without flexing, and in a direction transverse to its own plane, of a yielding gasket surrounding and supporting said diaphragm, said gasket being free to flex, and being held under an initial state of compression by said diaphragm, said gasket reacting to compress said diaphragm radially.

16. In a sound box, the combination with a dished diaphragm of substantially uniform thickness throughout its full extent, of a yielding gasket surrounding and support-

ing said diaphragm, said gasket being free to flex and being held in an initial state of compression by said diaphragm.

17. In a sound box, the combination with a diaphragm of a yielding gasket free to flex and supporting said diaphragm in an initial state of compression, said diaphragm reacting to hold said gasket under an initial state of compression.

18. In a sound box, the combination with a diaphragm vibratory as a whole without flexing, and in a direction transverse to its own plane, of a yielding gasket supporting said diaphragm and holding the same in an initial state of compression, said diaphragm reacting to hold said gasket in an initial state of compression.

19. In a sound box, the combination with a diaphragm vibratory as a whole without flexing and in a direction transverse to its own plane, of a yielding gasket entirely supporting said diaphragm and holding the same in an initial state of compression, said diaphragm reacting to hold said gasket in an initial state of compression.

20. In a sound box, the combination with a substantially inflexible diaphragm vibratory as a whole in a direction transverse to its own plane, of a yielding gasket inclosing said diaphragm and contacting with the peripheral edge thereof and holding said diaphragm in an initial state of compression, said diaphragm reacting through its marginal edge to hold said gasket in an initial state of compression.

21. A gasket for a sound box, comprising a continuous base portion, and a relatively thin web portion carried and surrounded by said base portion.

22. A gasket for a sound box, comprising a continuous base portion and a relatively thin web portion carried by said base portion and projecting into the space inclosed by said base portion.

23. A gasket for a sound box, comprising a continuous yielding base portion, and a relatively thin yielding web portion surrounded and carried by said base portion.

24. A gasket for a sound box, comprising a continuous yielding base portion, and a relatively thin yielding web portion surrounded and carried by said base portion and wholly included in the space surrounded by said base portion.

S. G. BROWN.

TELEPHONE RECEIVER.

APPLICATION FILED MAR. 27, 1911.

1,096,676.

Patented May 12, 1914

Fig. 1.

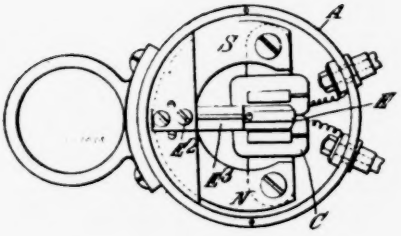

Fig. 2.

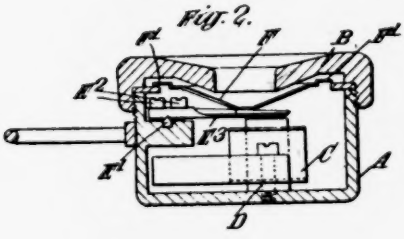

Fig. 3.

Witnesses:

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C. E. Keeler

Inventor

Sidney G. Brown

by James L. Morris & Co.

Attys

25. In a sound box, the combination with a diaphragm, of yielding means engaging the peripheral edge of the diaphragm and confined peripherally, and adjustable means for compressing said yielding means laterally to apply yielding pressure on the diaphragm in the plane of said edge.

26. A gasket for a sound box comprising a base portion, and a relatively thin flat web portion carried by said base portion and projecting inwardly from the internal surface of said base portion.

27. In a sound box, the combination with a diaphragm, of a yielding support engaging the peripheral edge of the diaphragm, and adjustable means acting on said yielding support to cause the same to apply different yielding pressures on the peripheral edge of the diaphragm in a plane substantially normal to the axis of the diaphragm.

28. In a sound box, the combination with a diaphragm, of yielding means engaging the peripheral edge of the diaphragm, and adjustable means acting on said yielding means to produce varying pressures of said yielding means on the diaphragm, said yielding means exerting a pressure on the peripheral edge of said diaphragm independently of said adjustable means.

29. In a sound box, the combination of a substantially inflexible diaphragm, a flexible web member supporting said diaphragm by engagement with the peripheral portion thereof, and means for causing stress in said flexible member to act on the periphery of said diaphragm solely in a plane substantially normal to the axis of said diaphragm.

30. In a sound box, the combination of a substantially inflexible diaphragm, a yielding member surrounding and [fol. 288] supporting said diaphragm, and means acting on said yielding member to vary the stress of said yielding member with respect to said diaphragm, said yielding member exerting a pressure on the peripheral edge of said diaphragm independently of said adjustable means.

In witness whereof, I have hereunto set my hand this 27th day of October, A. D. 1910.

John C. English.

Witnesses: Charles C. More, Frank B. Middleton, Jr.

(Here follows drawing, side folio 289.)

[fol. 290] United States Patent Office

Sidney George Brown, of London, England

Telephone-Receiver

Specification of Letters Patent

1,096,676. Patented May 12, 1914

Application filed March 27, 1911. Serial No. 617,228

To all whom it may concern:

Be it known that I, Sidney George Brown, a subject of the King of Great Britain, residing at 4 Great Winchester street, in the city and county of London, England, have invented certain new and useful Improvements Relating to Telephone-Receivers, of which the following is a specification.

This invention relates to the reproduction of sound by electrical means and has particular reference to telephone receivers, the chief object being to enable a high efficiency of conversion of oscillations or variations of electric current into acoustic vibrations to be obtained.

The usual telephone receiver consists of a polarized electromagnet through the coil of which the line currents pass, and a soft iron diaphragm gripped peripherally and thereby held a short distance away from the electromagnet. Variation in the strength of the line current cause the diaphragm to vibrate, and, in so doing, to set the surrounding air into vibration. The responsiveness of the diaphragm as usually employed and the transmission of its vibrations to the air are imperfect for several reasons. In the first place owing to the peripheral gripping of the diaphragm it cannot vibrate uniformly at all points on its surface; also owing to the diaphragm serving to complete the magnetic circuit of the electromagnet, its thickness is considerable; and, owing to this thickness of the diaphragm and to its being composed of iron, it is comparatively heavy with the result that its inertia makes it sluggish in action. Moreover in regard to the transmission of the vibrations through the air, sufficient attention has not been paid to the volume of air set in motion and the variations of air pressure for producing the

most effective transmission. The dimensions of the ear-drum and of the aural cavity may be taken as invariable factors in such considerations. Now these factors being known, there are certain relations existing between them and the size of the diaphragm, the nature of the air pressure variations, and the volume of air set in motion for the most effective reproduction of the sounds, and the transmission of them to the ear-drum.

The telephone receiver constructed in accordance with the present invention is designed to eliminate the causes of inefficiency above referred to.

According to this invention the diaphragm of the receiver is made extremely light but is so shaped that notwithstanding its extreme lightness it is comparatively rigid. I have found that a diaphragm of aluminum formed conically from a very thin disk of that metal and if necessary suitably stiffened by ribs, or corrugations, or otherwise, possesses the requisite properties to a satisfactory degree. The thin disk of aluminum may conveniently be spun into a conical shape with a flat center piece.

It is advantageous for the strength to be greatest at the center and progressively less toward the edge, and by starting the spinning operation at the edge and working toward the center, this property of the spun disk will be naturally produced owing to the graduated thickness of the disk. To increase this effect resort may be made to the known expedient of assembling several disks of different diameter into a pile. The thickness of such disks may be of the order of $2\frac{1}{2}$ thousandths of an inch. Some idea as to the lightness of a diaphragm so formed may be gained from the fact that when it is allowed to drop to the ground it does not fall like a heavy mass of metal, but moves gently through the air. The mere conical shape of the diaphragm will insure a considerable amount of rigidity but this may be increased by providing radial ribs or corrugations on it. This diaphragm is mounted upon a resilient member which responds to the variations of line current; the said resilient member may consist of a metal strip or reed containing within itself, by reason of a cut-away portion, its own control and that of the diaphragm. The diaphragm is preferably attached at its center to a point on the metal strip or reed slightly eccentric with respect to the axis of the coil

through which the line currents pass. The diaphragm is so arranged as to be free to move as a whole, that is to say all points on its surface vibrate equally, and to insure this action the periphery of the diaphragm is either quite free or is attached to the usual casing by a mere thin ring of flexible material. The inner face of the cover or ear-piece of the receiver is shaped to conform approximately to the [fol. 291] shape of the diaphragm, and is situated at a comparatively short distance from this diaphragm, thereby avoiding an undue amount of space between the diaphragm and the cover or ear-piece.

In order that the invention may be clearly understood and readily carried into effect I will now describe the same more fully with reference to the accompanying drawings, in which:—

Figure 1 is a plan with the cover removed, and Fig. 2 a sectional elevation, of one constructional form of my improved receiver. These drawings represent a full size receiver, and the more important dimensions such as the diameter of the diaphragm, the extent of its eccentricity, and the volume and shape of the air space between the diaphragm and the ear-piece or cover, are what I have found by experiment to give good results for hearing with the receiver close to the ear, by reason, no doubt, of the relation these dimensions bear to the diameter of the ear-drum and the volume of the aural cavity. When it is desired to make the sounds travel out into the room, a receiver of larger size is preferable. Fig. 3 is a detail view of a diaphragm built up of several diaphragms of different diameter.

A is the casing and B the ear-piece or cover of the receiver.

C represents the coil and D the core of a polarized electromagnet of which N and S are the north and south poles respectively.

E is a metal reed one end of which is held down upon a bridge piece E′ on the casing E by two adjusting screws E²; the free end of this reed extends over the core D of the electro-magnet. A portion E³ of this reed is cut away to increase its flexibility and decrease its weight. I have found that a suitable free period for the reed is from eight hundred to one thousand. The extent to which the reed E can approach the core D may be regulated by packing some

layers of paper between these parts or by arranging a set screw to make contact with the reed.

F is a light aluminum diaphragm of conical form. It is attached at its center to the reed E at a point eccentric with respect to the axis of the core D, the eccentricity being toward the fixed end of the reed. Although I have shown the best position for attaching the diaphragm in the particular receiver illustrated, the best position on any reed can be found by experiment by means of a stethoscope and by exploring the reed with the aid of a movable diaphragm.

The diaphragm F is flexibly attached at its periphery by a ring F′ of tissue paper or other suitable material that will not exert appreciable restraint upon the diaphragm, to a removable flange on the casing A. This ring F′ may be attached to the diaphragm and to the aforesaid flange by adhesive.

It will be understood that owing to the extreme lightness of the diaphragm and to its freedom from peripheral constraint, it will be highly responsive to movements of the reed E and will vibrate as a whole. It will also be observed that the function of the reed E is not to set the air in motion, but only to carry the diaphragm and control its movement. This reed contains, within itself, by reason of its cut away portion E′, the means of its own control and that of the diaphragm, and also serves to complete the magnetic circuit; the diaphragm forms no part of this circuit. The inner face of the cover or ear piece B conforms approximately to the shape of the diaphragm and its distance from the diaphragm is such as to give only the requisite air space between these two parts. The sectional area of the central hole or holes in the ear-piece is suitably proportioned to the aforesaid air space.

Although the invention has been described and illustrated with reference to a "watch" type of receiver, it is of course equally applicable to the long handle type of receiver.

What I claim and desire to secure by Letters Patent of the United States is:—

1. In a telephone receiver, a coil through which the line currents pass, a resilient metal reed responsive to vibrations of current in the coil, and having an intermediate cut-away portion to impart inherent flexibility, a light rigid peripherally unrestrained conical diaphragm carried by its

center on said reed, and an ear piece situated over the diaphragm.

2. In a telephonic receiver, a polarized electromagnet, a coil through which the line currents pass, a resilient metal reed responsive to variations of current in the coil and having an intermediate cut-away portion to impart inherent flexibility, a light peripherally unrestrained conical diaphragm carried by its center on said reed, and an ear piece situated over the diaphragm.

3. In a telephonic receiver, a polarized electromagnet, a coil through which the line currents pass, a resilient member responsive to variations of current in the coil, a light peripherally unrestrained conical diaphragm carried by its center on said member eccentrically with respect to the electromagnet, and an ear piece situated over the diaphragm.

4. In a telephonic receiver, a polarized electromagnet, a coil through which the line currents pass, a resilient metal reed serving as electromagnet armature and having an intermediate cut-away portion to impart inherent flexibility, a peripherally unrestrained conical diaphragm carried by its center on the free end of the said armature, and an ear piece situated over the diaphragm.

5. In a telephone receiver, a coil through which the line [fol. 292] currents pass, a resilient metal reed responsive to variations of current in the coil and having an intermediate cut-away portion to impart inherent flexibility, a light peripherally unrestrained conical diaphragm carried by its center on said reed, and an ear piece the inner face of which conforms approximately to the conical shape of the diaphragm.

6. In a telephone receiver, a casing, a polarized electromagnet attached to the back of the casing, a coil through which the line currents pass, a resilient metal reed responsive to variations of current in the coil and having an intermediate cut-away portion to impart inherent flexibility, a light conical diaphragm carried by its center on said reed with its apex pointing toward the back of the casing, and a cover or ear-piece with a conical inner face conforming approximately to that of the diaphragm.

7. In a telephone receiver, a diaphragm comprising a conically shaped sheet of metal thickest at the center and

E. R. JOHNSON.

SOUND BOX DIAPHRAGM.

APPLICATION FILED FEB. 16, 1912.

1,180,401.

Patented Apr. 25, 1916.

4 SHEETS—SHEET 1.

Fig. 1.

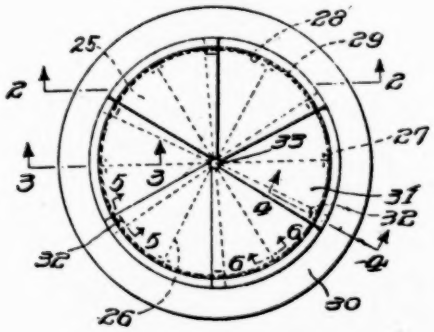


Fig. 2.

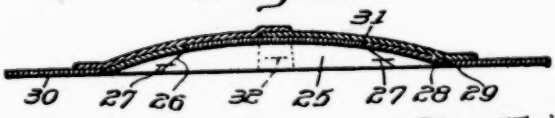


Fig. 3.

Fig. 4.

Fig. 7.

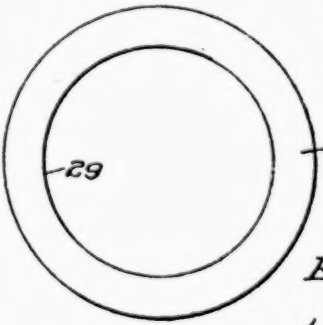


Fig. 5.

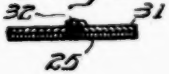
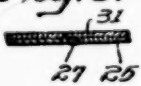


Fig. 6.



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APPLICATION FILED FEB 16, 1912.

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4 SHEETS—SHEET 2.

Fig. 8.

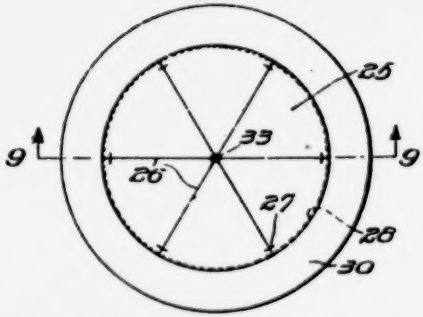


Fig. 9.

Fig. 10.

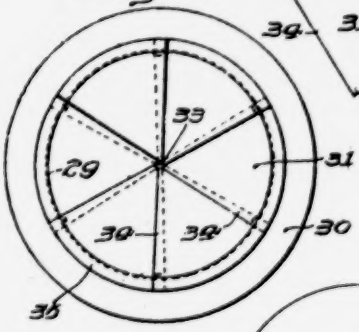


Fig. 11.

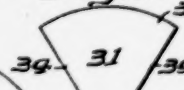


Fig. 12.

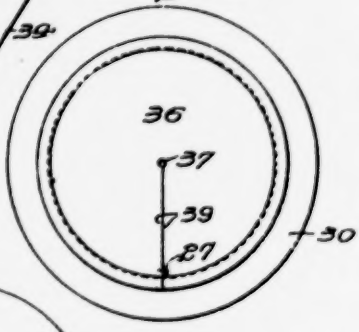
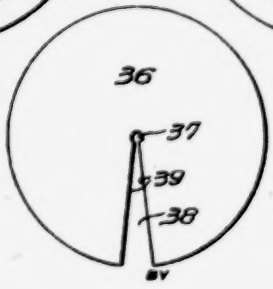


Fig. 13.



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SOUND BOX DIAPHRAGM.

APPLICATION FILED FEB. 16, 1912.

1,180,401. Patented Apr. 25, 1916.

4 SHEETS—SHEET 3.

Fig. 14.

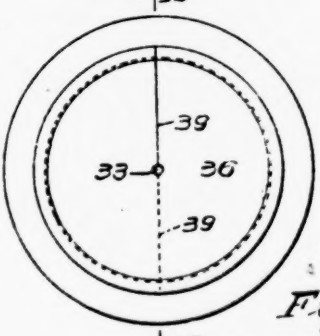


Fig. 16.

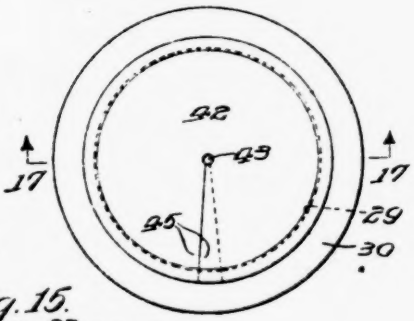


Fig. 15.

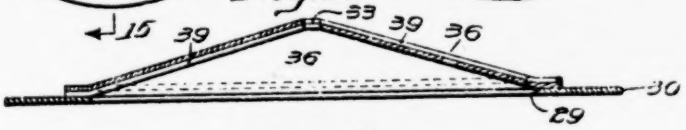


Fig. 17.

Fig. 18.

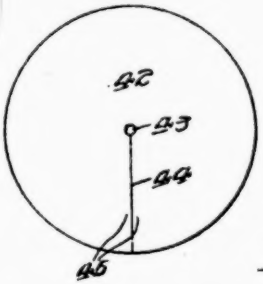


Fig. 19.

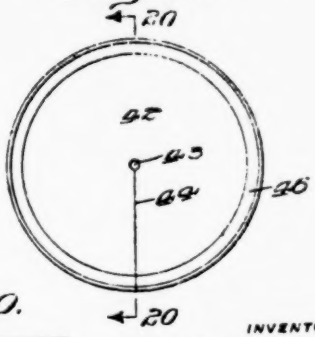
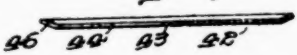


Fig. 20.



INVENTOR

Eldridge R. Johnson

BY

Wm. Fell

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WITNESSES

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Clifton C. Callwell

E. R. JOHNSON.
SOUND BOX DIAPHRAGM.
APPLICATION FILED FEB. 16, 1912.

1,180,401.

Patented Apr. 25, 1916.

4 SHEETS—SHEET 4.

Fig. 21.

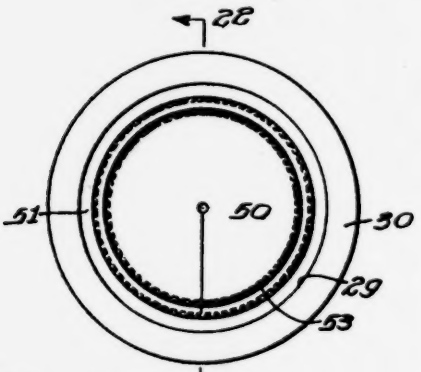

Fig. 22.

Fig. 23.

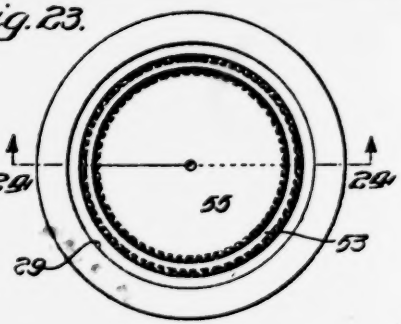

Fig. 24.

INVENTOR
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BY
Mac Ellis

ATTORNEY

progressively thinner toward the periphery, and a resilient member for carrying said diaphragm by its center.

8. In a telephone receiver, a conically spun aluminum diaphragm thickest at the center and progressively thinner toward the periphery, and a resilient member for carrying said diaphragm by its center.

9. In a telephone receiver, a diaphragm comprising a sheet of metal having a flat centerpiece and a conical flange portion the thickness of which decreases progressively toward the periphery, and a resilient member for carrying said diaphragm by its center.

10. In a telephone receiver, an aluminum diaphragm comprising a flat centerpiece and a conically spun flange portion the thickness of which decreases progressively toward the periphery, and a resilient member supporting the diaphragm by its center.

11. In a telephone receiver, a casing, a coil through which the line currents pass, a resilient member responsive to variations of current in the coil, a light conical diaphragm carried by its center on said member, an ear piece situated over the diaphragm, and a flexible ring of material connecting the periphery of the diaphragm to the casing, said material being so thin and light as to exert no appreciable restraint upon the diaphragm.

12. In a telephone receiver, a casing, removable flange thereon, a polarized electro-magnet, a coil through which the line currents pass, a resilient member responsive to variations of current in the coil, a light rigid diaphragm carried by said resilient member, and a thin flexible ring of material connecting the periphery of the diaphragm to the aforesaid removable flange, said material being so thin and light as to exert no appreciable constraint upon the diaphragm.

In testimony whereof I affix my signature in presence of two witnesses.

Sidney George Brown.

Witnesses: W. Henry Harvey, W. J. Skerten.

(Here follow drawings, side folios 293, 294, 295 and 296)

[fol. 297] United States Patent Office

Eldridge R. Johnson, of Merion, Pennsylvania, Assignor to Victor Talking Machine Company, a Corporation of New Jersey

Sound-box Diaphragm

Specification of Letters Patent

1,180,401. Patented Apr. 25, 1916

Application Filed February 16, 1912. Serial No. 678,120

To all whom it may concern:

Be it known that I, Eldridge R. Johnson, a citizen of the United States, and a resident of Merion, county of Montgomery, and State of Pennsylvania, have invented certain new and useful improvements in Sound-Box Diaphragms, whereof the following is a specification, reference being had to the accompanying drawings.

This invention is particularly directed to vibratory diaphragms for sound recording and reproducing devices, such as may preferably be adapted to the sound reproducing mechanism of a talking machine.

The principal object of this invention is, to provide a diaphragm that will readily respond to the most delicate and rapid vibrations, and accurately record and reproduce all of the high and low tones and the included range with equal clearness and with substantially the same intensity as the original sounds.

Other objects of this invention are, to provide a diaphragm of such construction as to substantially eliminate any stresses and strains that tend to produce false tones or in any way effect the intensity, accuracy and clearness of the reproduction; to provide a diaphragm having its engaged periphery formed of a relatively narrow separate member, and having its major portion separately formed and secured thereto.

Other objects of this invention are, to provide a diaphragm having a bulged major portion formed of a radially slitted disk of sheet material, such as mica, isinglass, celluloid, paper, and similar materials, having its opposed edges secured in overlapped relation; to provide a diaphragm

having a bulged major portion formed of a peripherally recessed disk of sheet material having its opposed edges secured in abutted relation; to provide a diaphragm having a bulged major portion formed of a plurality of sectoral sections respectively secured together, with their edges in overlapped relation; to provide a diaphragm having a bulged major portion formed of a plurality of sectoral sections respectively secured together, with their edges abutted; to provide a diaphragm having a bulged laminated portion formed of separate pieces having abutted edges, the abutted edges of the respective laminations being relatively out of registry; to provide a diaphragm having a bulged major portion formed of sections respectively having their edges secured to the edges of adjacent sections by stitching; to provide a diaphragm having a bulged major portion provided with a peripheral integral flange extended at an angle with respect to the central portion and in a plane normal to the axis of said diaphragm; and to provide a diaphragm having a bulged major portion, connected with a separate annular flange spaced therefrom by an annular web of relatively thin material.

Generally stated, the form of this invention hereinafter described provides a flat, annular, vibratory flange, to which is secured a bulged or conical substantially inflexible major portion adapted to reciprocate as a whole within the engaged peripheral edge of said annular flange.

In the accompanying drawings, Figure 1 is a face view of a diaphragm showing a convenient embodiment of this invention; Fig. 2 is a sectional view of said diaphragm taken on the line 2—2 in Fig. 1; Fig. 3 is a fragmentary sectional view of said diaphragm taken on the line 3—3 in Fig. 1; Fig. 4 is a fragmentary sectional view of said diaphragm taken on the line 4—4 in Fig. 1; Fig. 5 is a fragmentary sectional view of said diaphragm taken on the line 5—5 in Fig. 1; Fig. 6 is a sectional view of said diaphragm taken on the line 6—6 in Fig. 1; Fig. 7 is a face view of the annular peripheral supporting flange, per se; Fig. 8 is a face view of a modification of the diaphragm shown in Fig. 1; Fig 9 is a central transverse sectional view of the diaphragm shown in Fig. 8, taken on the line 9—9 in said figure; Fig. 10 is a face view of another modification of the diaphragm shown in Fig. 1; Fig. 11 is a face view of one of the segments forming the conical central portion of the diaphragm shown in

Fig. 10; Fig. 12 is another modification of the diaphragm shown in Fig. 1; Fig. 13 is a face view of the flat blank from which the central portion of the diaphragm shown in Fig. 12 [fol. 298] is formed; Fig. 14 is a face view of another modification of the diaphragm shown in Fig. 1; Fig 15 is a central transverse sectional view of the diaphragm shown in Fig. 14, taken on the line 15—15 in said figure; Fig. 16 is a face view of another modification of the diaphragm shown in Fig. 1; Fig. 17 is a central transverse sectional view of the diaphragm shown in Fig. 16, taken on the line 17—17 in said figure; Fig. 18 is a face view of the flat blank from which the central portion of the diaphragm shown in Figs. 16 and 17 is formed; Fig. 19 is a face view of the blank shown in Fig. 18, having its peripheral margin slightly turned up to form a flange for engagement with the annular ring shown in Fig. 7; Fig. 20 is a central transverse sectional view of the blank shown in Fig. 19, taken on the line 20—20 in said figure; Fig. 21 is a face view of another modified form of diaphragm; Fig. 22 is a central transverse sectional view of the diaphragm shown in Fig. 21, taken on the line 22—22 in said figure; Fig. 23 is a face view of another form of the diaphragm shown in Fig. 21; and Fig. 24 is a central transverse sectional view of the diaphragm shown in Fig. 23, taken on the line 24—24 in said figure.

In the omnibus form of this invention shown in Fig. 1 of the drawings, the central major portion of the diaphragm comprises a laminated structure formed of a plurality of sectoral members 25, respectively having their radial or lateral edges 26 abutted and joined by stitches 27, and having their circumferential or outer edges 28 abutted with the inner edge 29 of the peripheral annular supporting flange member 30. Superimposed upon the conical structure formed by the sectoral members 25, are a plurality of relatively broad sectoral members 31 respectively having their radial or lateral margins overlapping the margins of their adjacent members and conveniently secured together by any suitable means, preferably by an adhesive or by stitches 32, or both, and having their circumferential margins overlapping the annular flange 30.

As best shown in Fig 1, the abutted edges of the sectoral members 25 are preferably disposed intermediate of the overlapped margins of the sectoral members 31. The diaphragm thus formed is preferably provided with a central

aperture 33, for the convenient attachment with a stylus bar (not shown).

The form of this invention shown in Figs. 8 and 9 is a simplification of the diaphragm shown in Figs. 1 to 7, inclusive, and comprises a major central conical portion formed of sectoral members 25, preferably secured together by stitches 27, and having their circumferential or outer edges 28 in abutted relation to the inner edge 29 of the annular flange member 30, as the subjacent lamina formed by the members 25, shown in Fig. 1. The abutted radial or lateral edges 26 of the members 25, and the abutted circumferential or outer edges 28 of said sectoral members 25, and the edges 29 of the annular flange member 30 may preferably be secured by a suitable adhesive to form a substantially integral structure.

It is to be understood that while the stitches 27 are shown as disposed only near the periphery of the conical structure formed by the sectoral members 25, said sectoral members may be secured together by stitches disposed at different regions along the abutted edges, and, furthermore, the conical structure formed by said sectoral members 25 may be secured to the annular flange member 30 by stitches in the same manner.

The form of this invention shown in Figs. 10 and 11 is another simplification of the structure shown in Figs. 1 to 7, inclusive, and comprises the annular flange member 30, and the central conical major portion comprising the sectoral members 31 respectively having their radial or lateral margins 34 in overlapped relation with the adjacent sections, and their circumferential margins 45 flanged in a plane normal to the axis of the conical structure thus formed, and preferably secured by an adhesive in overlapped relation with the inner margin adjacent to the edge 29 of the annular flange member 30.

The form of this invention shown in Figs. 12 and 13 is a still further simplification of the structure shown in Figs. 1 to 7, inclusive, and comprises the annular flange member 30, and the central conical major portion formed of a single piece 36 of sheet material having a central circular opening 37 and a V-shaped recess 38, forming opposed edges 39 which are substantially radial to the center of the piece 36. The radial edges 39 formed by the recess 38 in the piece 36 are brought together and secured, preferably by an adhe-

sive or by the stitches 27, or both, as shown in Fig. 12, thus forming a conical major portion having a periphery of greater diameter than the inner diameter of the annular flange member 30, and having its peripheral margin in overlapped relation with the inner margin of the annular flange member 30, and secured thereto in any suitable manner, preferably by an adhesive.

The form of this invention shown in Figs. 14 and 15 is a structure similar to the form of the invention shown in Figs. 12 and 13, but having the central conical major portion laminated and comprising superimposed conically formed pieces 36 of sheet material, secured together with their respective abutted edges 39 disposed out of registry; that is to say, the abutted edges 39 of the subjacent conically [fol. 299] formed piece 36 being disposed beneath an uncut portion of the web of the superjacent conically formed piece 36, and the abutted edges 39 of said superjacent member being disposed over an uncut portion of the web of said subjacent member, the abutted edges 39 of the respective lamina being preferably disposed in alinement, as best shown in Fig. 14, the conical central major portion overlapping, and being secured to the inner margin of the annular flange member 30, adjacent to the edge 29.

The form of this invention shown in Figs. 16 to 20, inclusive, comprises a still further simplified structure, comprising the annular flange member 30, and the central conical major portion formed of a single piece 42 of sheet material, which, as best shown in Fig. 18, is a circular disk having a central aperture 43, and provided with a radial slit 44, forming opposed edges, the margins 45 along which may be overlapped, as shown in Fig. 16, to form the central conical substantially inflexible major portion of the diaphragm.

As shown in Figs. 19 and 20, the peripheral margin of the piece 42 may be slightly upturned to form a marginal flange 46 (see Fig. 20) before having the edges of the slit 44 overlapped. Thus it will be seen that when the margins 45 along the edges of the slit 44 are overlapped and secured together to form the conical piece 42, the flange 46 will occupy a position in a plane substantially normal to the axis of the conical central major portion formed by the piece 42, which flange 46 may be readily secured in any suitable manner, in overlapped relation with the inner margin of the annular flange member 30, as shown in Figs. 16 and 17.

The form of this invention shown in Figs. 21 and 22 is similar to the form shown in Figs. 12 and 13, in so far as the central conical major portion is concerned. In this form of the invention, however, the diameter of the conical central portion 50 is less than the inner diameter of the annular flange member 30, so, as best shown in Fig. 22, an annular gap 51 is formed between the outer periphery of the central portion 50 and the inner edge 29 of the annular flange member 30.

As best shown in Fig. 22, the central conical portion 50 may be secured to the annular flange member 30 by a relatively thin annular membrane 52, which is suitably secured to one face of the annular flange member 30, and to the inner peripheral margin of said conical portion 50 and an annular membrane 53 secured to the membrane 52 between the inner edge 29 of the annular flange member 30 and the outer edge of the portion 50, and overlapping the peripheral margin of said portion 50 and secured to its outer face. By this construction it will be seen that the central portion 50 being substantially inflexible, has a great freedom of reciprocation with respect to the flange member 30, with which it is connected by the relatively thin and highly flexible membrane.

The form of this invention shown in Figs. 23 and 24 is similar to the form shown in Figs. 14 and 15, in so far as the central conical portion of the diaphragm is concerned and comprises the conical central major portion 55 formed of limina members 56, substantially formed as shown in Fig. 13 and placed together substantially as shown in Figs. 14 and 15, inclusive. In this form of the invention, like the form shown in Figs. 21 and 22, the outer periphery of the central conical major portion of the diaphragm is less than the diameter of the inner edge of the annular flange member 30, and is joined by the membranes 52 and 53 respectively, as in said Figs. 21 and 22.

It is believed that by forming a diaphragm with an annular flange which is separate from and secured to a separately formed conical central major portion in the manner above set forth, undesirable strains and stresses which would be incident to the forming of a diaphragm of a single piece of sheet material having its central portion bulged, will be substantially eliminated, and the annular flange thus formed will be therefore more susceptible in responding to

the vibrations occasioned by sound waves, than if the diaphragm were formed of a single piece.

Although the diaphragm as above described is referred to generally as being formed of sheet material, it is to be understood that it is preferable to form said diaphragm of mica or like material, which, as will be noted, may be readily cut and formed into the desired shapes, and which may have its parts secured by stitching, to prevent the accidental separation of said parts.

It is not desired to limit this invention to the precise details of construction and arrangement herein set forth, as it is obvious that various modifications may be made therein without departing from the essential features of the invention as defined in the appended claims.

Having thus described by invention, I claim:

1. In a diaphragm, the combination with a separately formed annular flange member of sheet material, having inner and outer edges, of a conical central major portion having a central aperture and comprising a sectoral section of sheet material having radial edges secured together and a peripheral edge secured to the inner edge of said flange member.

2. In a diaphragm, the combination with a separately [fol. 300] formed annular peripheral flange member of sheet material, of a conical central major portion having a central aperture and comprising a sectoral section of sheet material, having radial edges secured together and a margin secured in overlapped relation with the inner margin of said annular flange member

3. In a diaphragm, the combination with a separately formed annular member of sheet material, having inner and outer edges, of a substantially conical central major portion having a central aperture and comprising a sectoral section of sheet material, having its radial edges secured together, and its peripheral edge secured to the inner edge of said annular member.

4. In a diaphragm, the combination with a separately formed annular member of a conical central major portion comprising a sectoral section, having its radial edges secured together and its peripheral edge extended over the inner margin of said annular member and secured thereto.

5. In a diaphragm, the combination with a separately formed annular member, of a conical central major portion

comprising a sectoral section of sheet material, having its radial edges secured together, and its peripheral margin extended to form a flange, in a plane normal to the axis of the conical structure thus formed, and means for securing said flanged portion with said annular member.

6. In a diaphragm, the combination with a separately formed annular member, of a conical central major portion comprising a sectoral section of sheet material, having the margins along its radial edges secured in overlapped relation, and its peripheral edge secured to said annular member.

7. In a diaphragm, the combination with a separately formed annular member of sheet material, of a conical central major portion comprising a sectoral section of sheet material, comprising a substantially circular disk having a radial slit, the margins along said slit being secured in overlapped relation, and having its peripheral margin secured to said annular member.

8. In a diaphragm, the combination with a separately formed annular member, of a bulged central major portion having a central aperture and comprising a sectoral section of sheet material formed of a disk having a radial slit, the margins along said slit being secured in overlapped relation, and the peripheral margin being flanged in a plane normal to the axis of the bulged structure thus formed, said flange being secured in overlapped relation with said annular member.

9. In a diaphragm, the combination with a separately formed member of sheet material, having inner and outer edges, of a conical central major portion comprising a sectoral piece of sheet material, having its lateral margins secured in overlapped relation, and having its outer margin extended over a portion of said annular member and secured thereto.

10. A diaphragm formed of an annular peripheral member of sheet material, and a separately formed central major portion comprising a disk of sheet material slitted radially and having its peripheral edge upturned to form a flange for engagement with said peripheral member.

11. A diaphragm formed of an annular peripheral member of mica, and a separately formed central major portion

comprising a disk of mica slitted radially and having its peripheral edge upturned to form a flange for engagement with said peripheral member.

12. A diaphragm formed of a peripheral member of mica, and a separately formed central major portion comprising a disk of mica slitted radially and having its marginal radial edges overlapped and secured together by stitches.

13. A diaphragm comprising an annular member forming the outer portion of the diaphragm, and a cup-shaped member having an outer marginal edge secured to said annular member, and having edges secured together and extending inwardly from said marginal member, said cup-shaped member forming the central portion of said diaphragm.

14. A diaphragm comprising a substantially flat annular member forming the outer part of the diaphragm, and a cup-shaped member secured marginally to the inner margin of said annular member and provided with radial edges secured together.

15. A diaphragm comprising a substantially flat annular member forming the outer part of the diaphragm, and a cup-shaped member secured marginally to the inner margin of said annular member and provided with radial overlapped edges secured together.

16. In a diaphragm, the combination with a separately formed annular member of sheet material, having inner and outer edges, a cup-shaped central major portion, comprising sheet material having edges secured together and extending from the inner edge of said annular member inwardly, and having a peripheral edge secured to the inner edge of said annular member

17. A diaphragm comprising a cup-shaped member having edges extending from the periphery of the disk inwardly and secured together, and an annular member of sheet material, secured to the marginal portion of said disk.

18. A diaphragm comprising an annular member forming [fol. 301] the outer portion of the diaphragm and a disk of sheet material slit from the periphery thereof toward the center and having the edges adjacent said slit secured together to form a cupped member and the edge of the cupped member so formed being secured to the inner edge of said annular member.

J. H. ELFERING.

SOUND BOX DIAPHRAGM.

APPLICATION FILED NOV. 12, 1910.

1,182,078. Patented May 9, 1916.

Fig. 1.

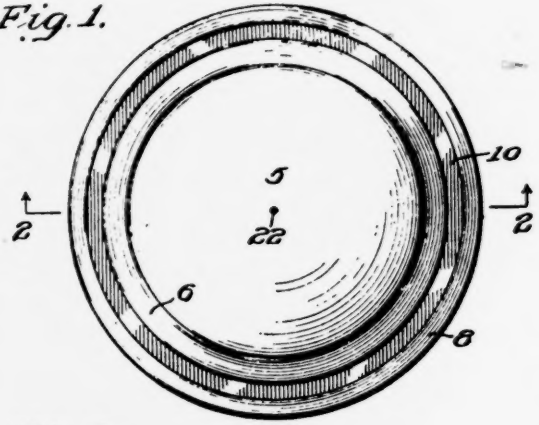


Fig. 2.

Fig. 3.

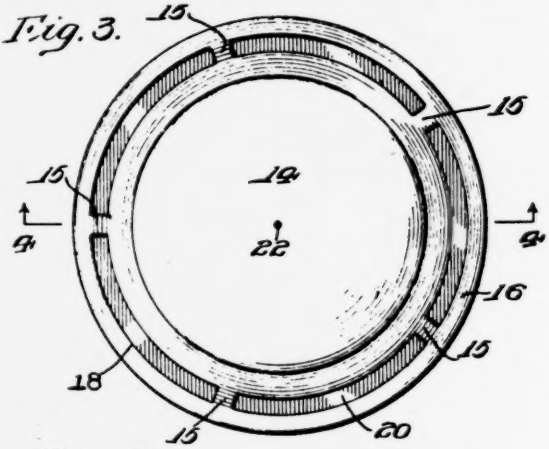


Fig. 4.

INVENTOR

John H. Elfering.

WITNESSES

F. J. Haltinaul.

Clifton C. Hallowell

BY

ATTORNEY

In witness whereof, I have hereto set my hand this 9th day of February, A. D. 1912.

Eldridge R. Johnson.

Witnesses: Charles F. Willard, Frank B. Middleton, Jr.

(Here follows drawing, side folio 302)

[fol. 303] United States Patent Office

John H. Elfering, of Camden, New Jersey, Assignor to Victor Talking Machine Company, a Corporation of New Jersey

Sound-box Diaphragm

Specification of Letters Patent

1,182,078. Patented May 9, 1916

Application Filed November 12, 1910. Serial No. 591,947

To all whom it may concern:

Be it known that I, John H. Elfering, a citizen of the United States, and a resident of Camden, in the county of Camden and State of New Jersey, have invented certain new and useful improvements in Sound-Box Diaphragms, whereof the following is a specification, reference being had to the accompanying drawing.

This invention particularly relates to diaphragms for sound recording and reproducing devices, such as are preferably adapted to talking machines.

The principal object of this invention is to provide a diaphragm that will readily respond to the most delicate vibrations and accurately record and reproduce all of the high and low tones and the included range with equal clearness.

Further objects of this invention are to provide a diaphragm having its major portion formed substantially inflexible and capable or reciprocation independently of its margin; and to provide means to flexibly connect said inflexible major portion with said margin.

The form of this invention hereinafter described provides a diaphragm comprising a central conically dished inflexible plate, having a peripheral flange in a plane in substantially perpendicular relation to the axis of said conical plate, a separate annular margin surrounding said flange in a plane therewith, and a thin flexible imperforable membrane connecting said flange and margin and arranged to support said inflexible plate.

This invention further includes all of the various novel features of construction and arrangement hereinafter more definitely specified.

In the accompanying drawing Figure 1 is a front elevational view of a diaphragm showing the preferred embodiment of this invention; Fig. 2 is a central transverse sectional view taken on the line 2—2 in Fig. 1; Fig. 3 is a front elevational view of a modification of the structure shown in Fig. 1; and Fig. 4 is a tranverse sectional view of the diaphragm shown in Fig. 3 and taken on the line 4—4 in said figure.

In the form of this invention shown in Figs. 1 and 2 the central major portion of the diaphragm comprises the conically dished disk or plate 5, which as best shown in Fig. 2 has the peripheral flange 6 extended in a plane in perpendicular relation to the axis of said diaphragm and surrounded by the annular marginal member 8 in spaced relation to the periphery of said flange 6, and in a plane therewith. Said marginal member 8 is connected with the flange 6 by a thin membrane 10, which may be formed by any suitable imperforable flexible material, preferably gold beater's skin, and which may be conveniently secured to said connected members by any suitable adhesive material. Said membrane 10 is arranged to support the central conical plate 5 in reciprocatory relation to the marginal member 8 which may be suitably secured in a sound box of any convenient construction.

It may be here noted that the diaphragm may be formed of any suitable material preferably paper or other fibrous material which may be treated with a resinous solution or other convenient material to render it impervious to any atmospheric conditions or moisture or may be formed of any stiff sheet material.

The form of this invention shown in Figs. 3 and 4, provides a diaphragm similar to the diaphragm shown in Figs. 1 and 2, and comprises the rigid central portion forming the conically dished plate 14 which is connected by the narrow webs or spokes 15 with a sound box engaging marginal portion 16, forming the arc-shaped apertures 18, which are local to the periphery of said diaphragm, and which permit the free relative vibration of the central portion or plate 14, with respect to the marginal portion 16 to which it is connected by the flexible membrane 20. As best shown in Figs. 1 and 3, the central plates 5 and 14 are respectively provided with apertures 22, for the convenient attachment of a stylus bar (not shown) which may be cooperative therewith to record and reproduce sound.

It is well known that in diaphragms wherein the margin is engaged in a sound box, and the intermediate portion is free to vibrate to reproduce sound, the central portion which is connected with the stylus bar is afforded the maximum vibration, while the surface intermediate of the central portion and the periphery vibrates with varying force diminishing toward the margin of the diaphragm which is engaged. Therefore it will be readily observed that a dia- [fol. 304] phragm constructed in accordance with this invention is advantageous in that the major portion is substantially inflexible, and is reciprocated bodily, thus vibrating substantially uniformily throughout its extent, and consequently the compression and rarefaction of the air in the sound conveyor due to the vibration of said diaphragm is uniform throughout its extent.

It is not desired to limit this invention to the precise details of construction and arrangement herein set forth, as it is obvious that various modifications may be made therein without departing from the essential features of the invention as defined in the appended claims.

Having thus described my invention, I claim:

1. A diaphragm having a substantially rigid major central portion, a marginal portion connected thereto by relatively narrow flexible radial sections, and a flexible concentric membrane intermediate of said central and said marginal portions.

2. A diaphragm having a rigid major central portion connected with a marginal portion by integral relatively

narrow flexible radial sections and a flexible web connecting said central portion and marginal portion together.

3. A diaphragm comprising a central comparatively rigid conical dished major portion, a surrounding portion and a plurality of radial webs and an annular web connecting said portions.

In witness whereof I have hereunto set my hand and seal this 9th day of November A. D. 1910.

John H. Elfering. (L. S.)

Witnesses: Edward E. MacEwan, Frank B. Middleton, Jr.

(Here follows drawing, side folio 305)

[fol. 306] United States Patent Office

John C. English, of Camden, New Jersey, Assignor to Victor Talking Machine Company, a Corporation of New Jersey

Sound-Box

Specification of Letters Patent

1,192,289. Patented July 25, 1916

Application filed January 23, 1912. Serial No. 672,961

To all whom it may concern:

Be it known that I, John C. English, a citizen of the United States, and a resident of the City of Camden, county of Camden, and State of New Jersey, have invented certain new and useful Improvements in Sound-Boxes, of which the following is a specification.

The main objects of this invention are to provide in a sound box for talking machines, adjustable means for supporting the major portion of the same; to provide in a sound box an improved diaphragm and mounting therefor; and to provide other improvements as will appear hereinafter, the purpose as a whole being to provide a sound box that will be extremely efficient in operation.

In the accompanying drawings, Figure 1 is a fragmentary front elevation of a sound box constructed in accord-

J. C. ENGLISH.

SOUND BOX,

APPLICATION FILED JAN. 23, 1912.

1,192,289.

Patented July 25, 1916.

Fig. 1.

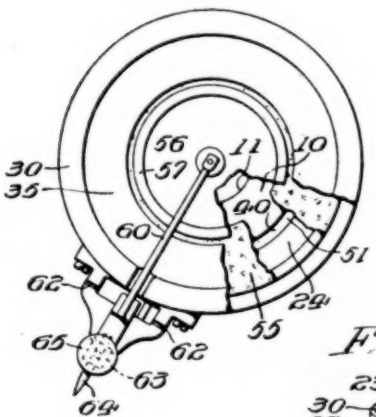


Fig. 2.

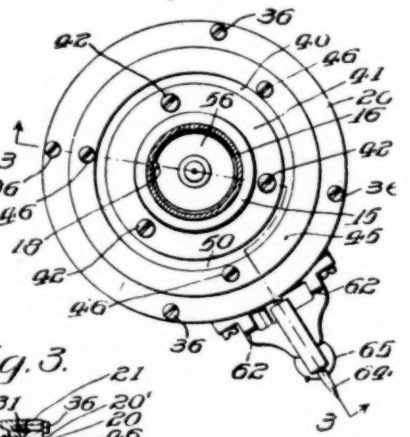


Fig. 3.

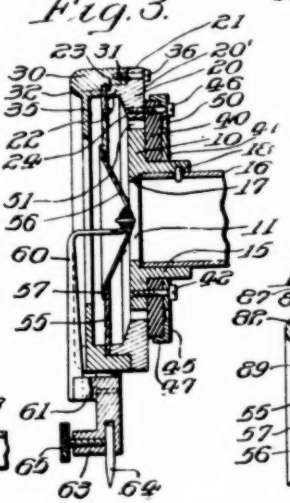


Fig. 4.

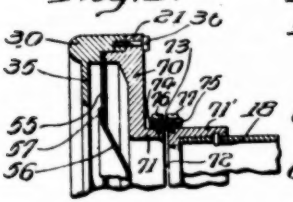
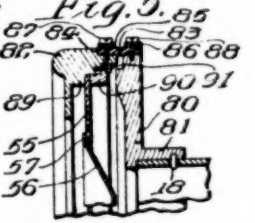


Fig. 5.



INVENTOR

John C. English.

WITNESSES

F. J. Hartman.

A. L. Gardner.

ATTORNEY

ance with this invention; Fig 2 a rear elevation of the same; Fig. 3 a longitudinal section on line 3—3 of Fig. 2; and Figs. 4 and 5 are fragmentary longitudinal sections of two modified forms respectively of the same.

Referring to the drawings, one embodiment of this invention consists of a sound box comprising a casing, including a flat annular supporting plate or member 10, co-axial with the casing and forming a portion of the back thereof. This supporting plate 10 is preferably made of comparatively rigid material, such as brass or any other suitable metal. Surrounding the central opening 11 of this plate 10 and projecting rearwardly from the plate, and integral or rigid therewith, is a tubular extension 15, which is adapted to telescope over the open free end of the usual or any suitable hollow tone arm 16 or other support. The internal diameter of the tubular extension 15 is preferably somewhat greater than the diameter of the central opening 11 of the supporting plate 10, thus forming an internal annular shoulder 17 between the tubular extension 15 and the supporting plate 10, this shoulder being adapted to abut against the inner end of the hollow tone arm 16 to assist in holding the sound box in position upon the tone arm. The usual pin 18 projects inwardly from the tubular extension 15 rigid therewith, and is adapted to perform its usual function of engaging in a bayonet slot in the tone arm 16. The diameter of the opening 11 in the supporting plate and the internal diameter of the tone arm 16, are preferably made equal so that the inner surface of the tone arm 16 will be flush with the cylindrical wall of the opening 11.

Surrounding the supporting plate 10 co-axial therewith and slightly spaced therefrom, is an annular marginal member 20, also forming a portion of the back of the casing of the sound box, and preferably made of the same material as the supporting plate 10, or of any suitable comparatively rigid material. The rear surface 20′ of this marginal member 20, is preferably flat and normally flush with the rear surface of the supporting plate. This marginal member 20 is provided upon its outer margin with an outwardly projecting flat annual- flange 21, integral and coaxial therewith and arranged flush with the rear surface 20′ of the marginal member. The marginal member 20 projects forwardly from its flat annular flange 21 in the

form of a cylindrical flange 22 having a flat annular forwardly facing end wall 23. From the cylindrical flange 22, the marginal member 20 tapers inwardly in thickness measured in a direction perpendicular to the rear surface 20′, and the inner face 24 of the member 20 is conical in form and coaxial with the tubular extension 15.

Telescoping snugly over the cylindrical flange 22 of the marginal member 20 is a hollow cylindrical cap 30, also preferably made of brass or other suitable comparatively rigid material. This cap 30 has a flat annular rear wall 31 normally abutting against the front face of the flange 21 of the marginal member 20, and is provided with an internal annular shoulder 32 normally spaced slightly in front of the end wall 23 of the flange 22 of the marginal member 20 and of equal dimensions. The front portion of the cap 30 is provided with an inwardly projecting flat thin annular flange 35, coaxial and integral or rigid therewith. The cap 30 is secured to the marginal member 20 by means of screws 36 extending through the flange 21 and threaded into the rear wall of the cap, or by any other suitable means.

[fol. 307] For yieldingly supporting the marginal member 20 and cap 30 carried thereby, a flat yielding annulus 40 snugly surrounds the tubular extension 15 and is secured to the rear wall of the supporting plate 10 and also to the rear wall of the marginal member 20. This yielding annulus 40 is preferably made of felt, leather, paper, cork, rubber, or any other similar or suitable yielding material. It has been found that felt gives very good results in this connection. The annulus 40 is preferably clamped securely against the rear wall of the supporting plate 10 by means of a metal or other comparatively rigid annular washer 41, fitting snugly around the tubular extension 15, and clamped against the rear face of the annulus 40 by means of headed screws 42, extending loosely through the washer 41 and annulus 40 and threaded into the supporting plate 10. The annulus 40 is also preferably clamped securely against the rear wall of the marginal member 20 by means of a similar flat annular outer washer 45, surrounding and spaced from the inner washer 41 and clamped against the rear wall of the annulus 40 by means of headed screws 46 extending loosely through the washer and annulus and

threaded into the marginal member 20. The screws 42 through the inner washer 41 are preferably arranged in staggered relation with respect to the screws 46 of the outer washer 45. This outer washer 45 is preferably provided with an inwardly projecting marginal cylindrical flange 47 which engages snugly over the outer marginal wall of the annulus 40, and the inner end wall of which is normally spaced slightly from the rear wall of the marginal member 20. This flange 47 serves to confine the annulus 40 within certain limits and also protects the margin of the annulus and improves the appearance of the sound box.

The annular space 50 between the inner and outer washers 41 and 45 is preferably opposite and substantially equal in area to the area of the space 51 between the supporting plate 10 and the marginal member 20, and these spaces are preferably only of sufficient width to permit of a desirable amount of yielding or flexing of the annulus 40 throughout the annular portion of the annulus included between these two annular spaces.

Any suitable diaphragm may be used in connection with the casing of this improved sound box, but in the present instance, an improved diaphragm, which has been made the basis of a separate application, is shown in this connection. This improved diaphragm comprises a thin flat outer annular portion 55, made of cork or a composition of cork, or made of other subereous or suitable yielding material, having little, if any tendency, to set up local vibrations. Surrounded by the flat annular portion 55 is a thin comparatively rigid cupped or conical portion 56, made of any suitable material, such as stiff paper, and arranged normally coaxial with the sound box casing, and having its convex side facing rearwardly. The marginal portion 57 of this conical portion 56 is preferably slightly flattened and overlaps the inner margin of the flat annular portion 55 and is secured thereto, preferably upon the front side thereof, by means of cement or glue, or in any other suitable manner.

The outer marginal portion of the diaphragm is clamped securely in position by and between the end wall 23 of the marginal member 20 of the internal shoulder 32 of the cap 30 of the sound box casing. The nature of the material forming the marginal portion of the diaphragm is such

that when the diaphragm is thus clamped in position, it adheres to the walls between, and by which it is clamped and any possibility of leakage of the air around the outer margin of the diaphragm is thus avoided, and also any tendency of the diaphragm to rattle is avoided.

Connected to the central portion or apex of the conical portion 56 of the diaphragm is one end of a stylus bar 60, which projects outwardly from the conical portion in a direction substantially coaxial therewith to a point in front of the flange 35 of the cap 30, and then turns radially outwardly in a direction parallel to the flange 35 and spaced slightly in front thereof. The outer portion 61 of this stylus bar is offset rearwardly outside of the cap 30 and is mounted upon the cap 30 to oscillate in respect thereto by means of spaced yielding connections 62, these yielding connections being preferably arranged so that the axis of oscillation of the stylus bar is substantially in a plane with the flat annular portion 55 of the diaphragm. The stylus bar is provided with an enlarged outer end 63 adapted to hold the usual or any suitable stylus 64, which is held in place by the usual set screw 65.

From the foregoing description, it is evident that in the construction described, the sound box casing may be considered broadly as being composed of two independently movable rigid members, one of which, including the marginal member 20 and the cap 30, carries the diaphragm and cooperating stylus, and the other of which including the supporting plate 10 and its tubular extension 15, is adapted to be mounted upon the tone arm 16 or other suitable carrier, these two main portions of the sound box casing being connected by a yielding or hinge-like means which permits of the relative movement of the main portions of the casing, and also acting as a closure for the space between these portions. It is also evident that the yielding [fol. 308] annulus 40 may be placed under a greater or less initial tension by adjusting the screws 42 and 46 to vary the compression of the annulus and that this variation of the initial aperture or tension would correspondingly affect the yielding qualities of the annulus and the freedom of movement between the two main portions of the sound box casing, and give a corresponding modification in the volume and quality of reproduction. It is also evident that in the

operation of this sound box, the central portion of the diaphragm will vibrate as a whole without flexing, and the surrounding portion will flex to permit of this vibration.

Instead of forming the back of the sound box casing as hereinbefore described, of two spaced annular members, one surrounding the other, the back of the sound box may be formed of a single piece as indicated at 70 in Fig. 4, and having a tubular extension 71, 71′ divided and spaced apart as at 72, the two portions 71 and 71′ of the tubular extension being yieldingly connected by a cylindrical ring 73 of yielding material, such as felt or rubber, etc., snugly surrounding the tubular extension and clamped to the two portions of the extension by means of comparatively rigid flanged rings 74 and 75 held in place by screws 76 and 77 extending through the rings and threaded into the two portions 71 and 71′ respectively of the tubular extension.

A further modification of this invention consists in forming the back of the sound box casing and its tubular extension in one part, as indicated at 80 and 81, respectively, and having an annular cap 82 spaced slightly in front of the back 80 and yieldingly connected thereto by means of a yielding cylindrical ring 83 surrounding the back 80 and engaging in an annular recess 84 provided therefor in the outer surface of the cap 82, the yielding ring 83 being clamped in position against the cap 82 and the back 80 by means of the rings 85 and 86 surrounding the yielding ring and held in place by screws 87 and 88 respectively, extending through the rings and threaded in to the cap and the back respectively. In this case, the diaphragm is clamped in place between a ring 89 and the flanged ring 90 carried by the cap 82, the latter ring being clamped in position by means of screws 91 extending through the ring and threaded into the cap.

This invention is not limited to any specific construction disclosed, as various changes might be made in applying this invention without departing from the spirit of the invention or the scope of the appended claims.

Having thus fully described my invention, I claim and desire to protect by Letters Patent of the United States:

1. A sound box casing comprising two spaced portions, yielding substantially nonresilient means connecting said portions and means arranged to limit the outward radial expansion of said first-named means.

2. A sound box comprising an annular supporting member provided with a tubular extension rigid therewith, an annular marginal member surrounding and spaced from said supporting member, and yielding means surrounding said tubular extension and connecting said supporting member and said annular marginal member.

3. A sound box comprising an annular supporting member provided with a tubular extension, an annular marginal member surrounding said supporting member, a diaphragm carried by said marginal member, and yielding means surrounding said tubular extension and connecting said supporting member and said marginal member.

4. A sound box comprising an annular supporting member, an annular marginal member surrounding said supporting member and spaced therefrom, yielding means connecting said members and forming a closure for the space between the same, and a diaphragm carried by said marginal member.

5. A sound box comprising an annular supporting member provided with a tubular extension rigid therewith, a second annular member surrounding said first-mentioned annular member, a diaphragm carried by said second annular member, and yielding means connecting said annular members.

6. A sound box comprising an annular supporting member provided with a tubular extension rigid therewith, an annular marginal member surrounding said supporting member and spaced therefrom, and a flat yielding annulus surrounding said tubular member and connecting said members.

7. A sound box comprising a casing including an annular supporting member provided with a tubular extension rigid therewith, an annular marginal member surrounding said supporting member and spaced therefrom, a substantially flat yielding annulus snugly surrounding said tubular extension and connecting said members, and annular means overlapping and engaging the outer margin of said annulus for holding the same in position.

8. A sound box comprising a casing including an annular supporting member having a tubular extension rigid therewith, an annular marginal member surrounding said supporting member and spaced therefrom, a yielding annulus surrounding said tubular extension outside of said mem-

bers, a washer surrounding said tubular extension, means for clamping said washer against said annulus, an outer washer surrounding and spaced from said first mentioned [fol. 309] washer, and means connected to said annular marginal member for clamping said outer washer against said annulus.

9. A sound box comprising a casing including an annular supporting member having a tubular extension rigid therewith, an annular marginal member surrounding said supporting member and spaced therefrom, a yielding annulus surrounding said tubular extension outside of said members, a washer surrounding said tubular extension, means for clamping said washer against said annulus, an outer washer surrounding and spaced from said first mentioned washer, and means connected to said annular marginal member for clamping said outer washer against said annulus, said latter washer being provided with an inwardly projecting marginal flange overlapping and engaging the marginal edge of said annulus.

10. A sound box comprising an annular supporting member provided with a tubular extension rigid therewith, an annular marginal member surrounding and spaced from said supporting member, an annular cap carried by said marginal member, a diaphragm clamped between said cap and said marginal member, and yielding means connecting said supporting member and said marginal member.

11. A sound box comprising an annular supporting member provided with a tubular extension rigid therewith, an annular marginal member surrounding and spaced from said supporting member, an annular cap carried by said marginal member, a diaphragm clamped between said cap and said marginal member, and yielding means connecting said supporting member and said marginal member, said diaphragm comprising a flat, annular yielding portion, and a comparatively rigid central portion surrounded by and secured to said flat yielding portion.

12. A sound box comprising an annular supporting member provided with a tubular extension rigid therewith, an annular marginal member surrounding and spaced from said supporting member, an annular cap carried by said marginal member, a diaphragm clamped between said cap and said marginal member, and yielding means connecting

said supporting member and said marginal member, said diaphragm comprising a flat, annular yielding subereous portion, and a comparatively rigid central portion surrounded by and secured to said flat yielding portion.

13. A sound box casing comprising two separately movable portions, yielding means forming the sole connection between the said portions and means arranged to compress said yielding means in one direction, said yielding means being held against expansion in a direction transverse to said first-mentioned direction.

14. A sound box casing comprising two spaced portions, yielding means holding said portions in spaced relationship, means to subject said yielding means to different degrees of compression, and means to limit the outward expansion of said yielding means.

15. A sound box casing comprising spaced portions, yielding annular means holding said portions in spaced relationship, means to subject said annular means to different degrees of compression and annular relatively rigid means inclosing said yielding means to limit the outward expansion of said yielding means.

16. A sound box casing comprising two spaced portions, yielding annular means forming a closure for the entire space between said portions, means clamping said yielding means to one of said portions, and means clamping said yielding means to the other said portions, said portions being in contact with said yielding means upon one side only of said yielding means.

In witness whereof, I have hereunto set my hand this 19th day of January, A. D. 1912.

John C. English.

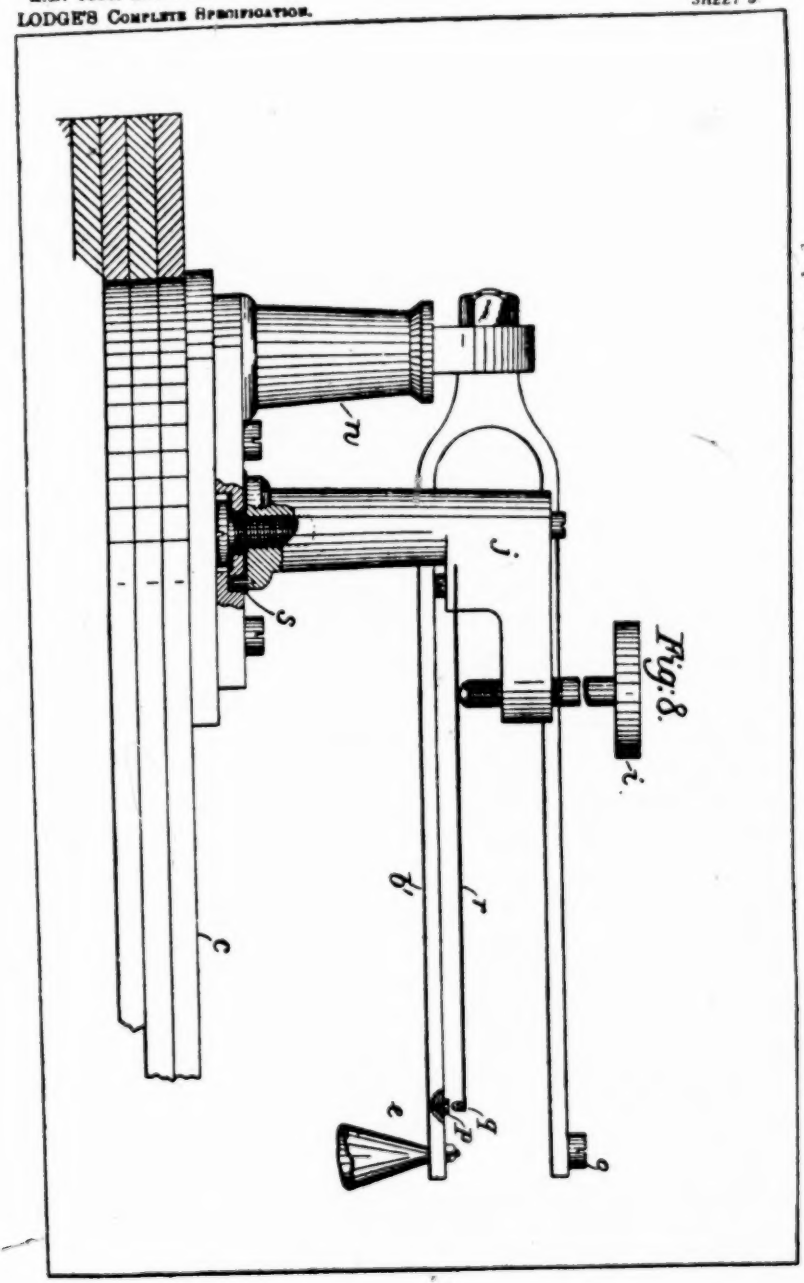
Witnesses: Edward K. MacEwan, John D. Myers.

(Here follow drawings, side folios 310, 311, and 312)

[fol. 313] Also I may use differentially-wound or other transformers for the purpose of communicating electrically between each microphone and the receiving or vibrating coil of the next in the series. The vibrating coils may be wound of fine wire compacted together with cement such as shellac,

A.D. 1898. April 27. N° 9712.
LODGE'S Complete Specification.

(3 SHEETS)
SHEET 3



[This Drawing is a reproduction of the Original on a reduced scale.]

Fig:1.

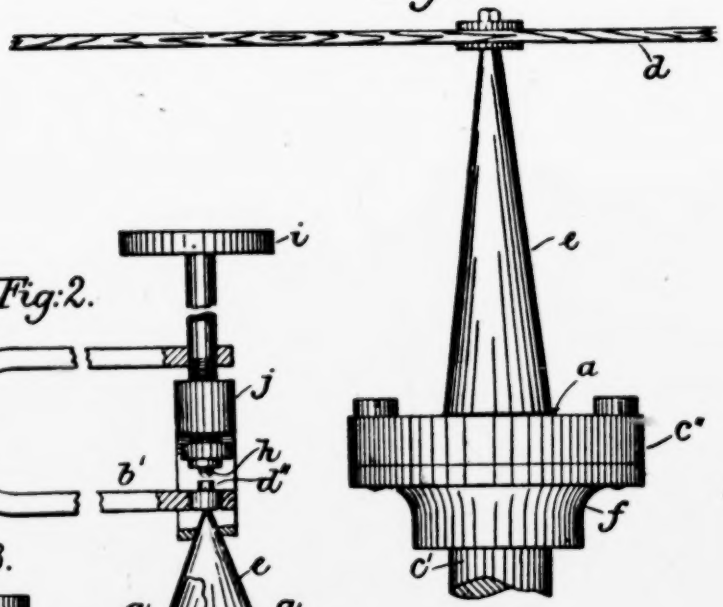


Fig:2.

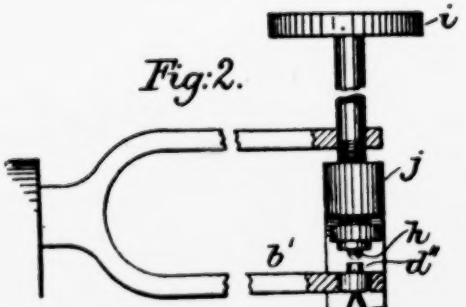


Fig:3.

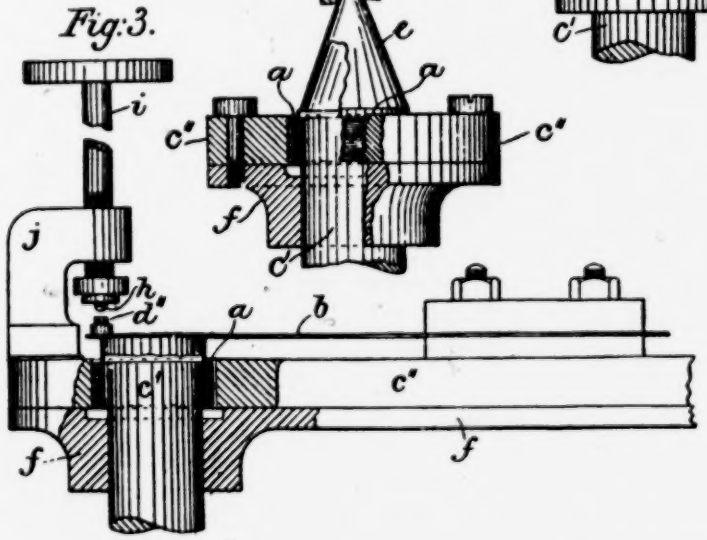
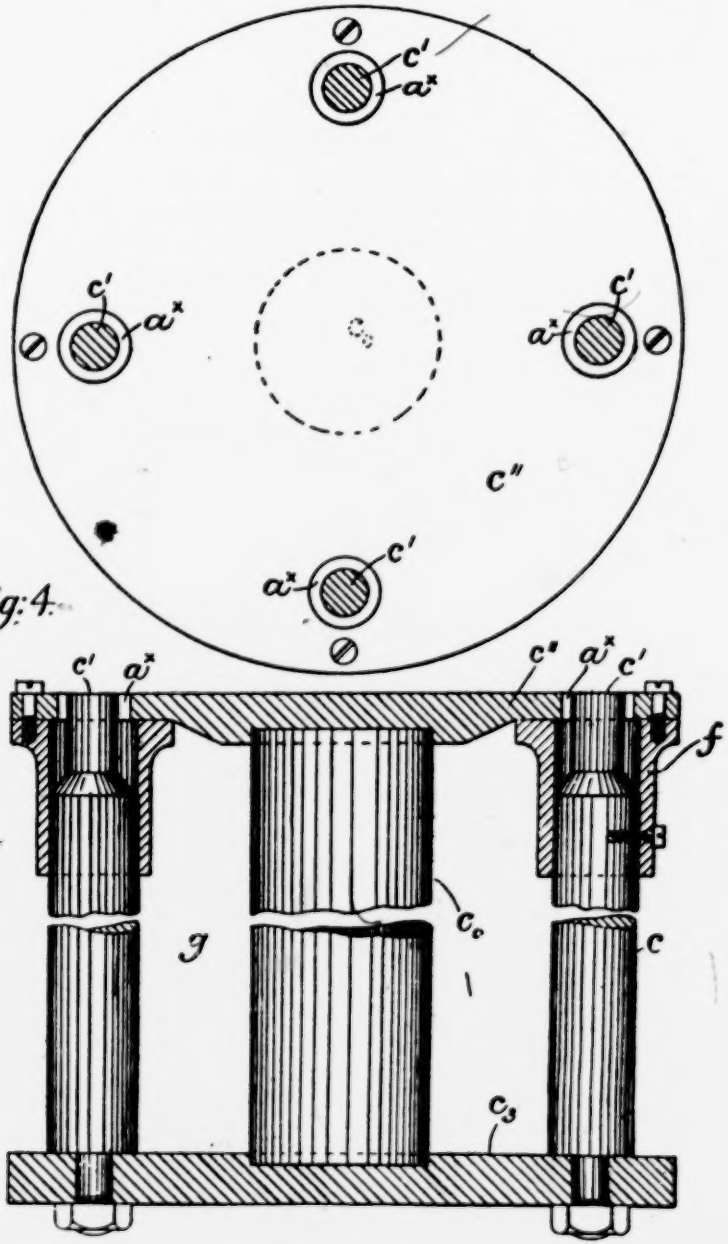
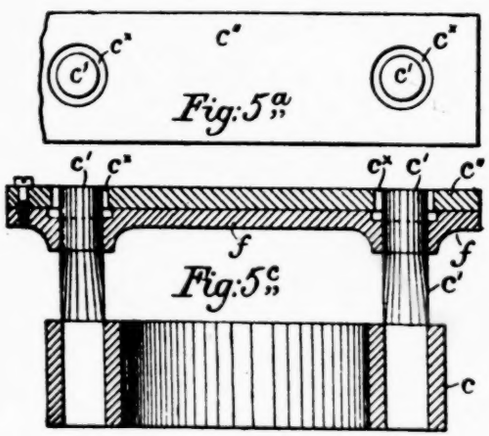
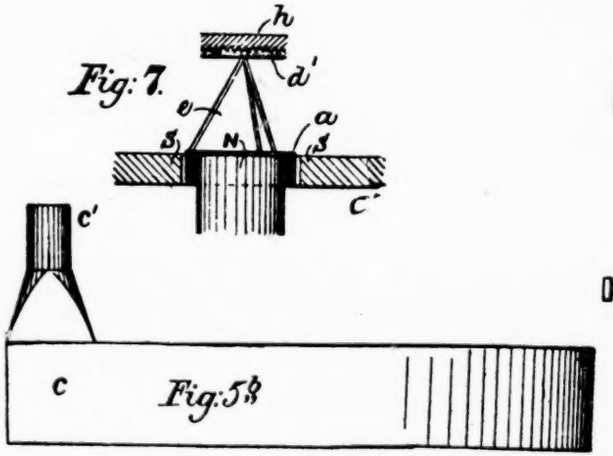


Fig:4.







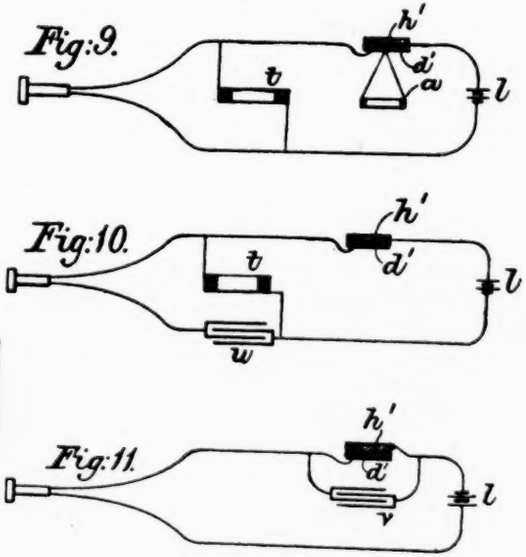
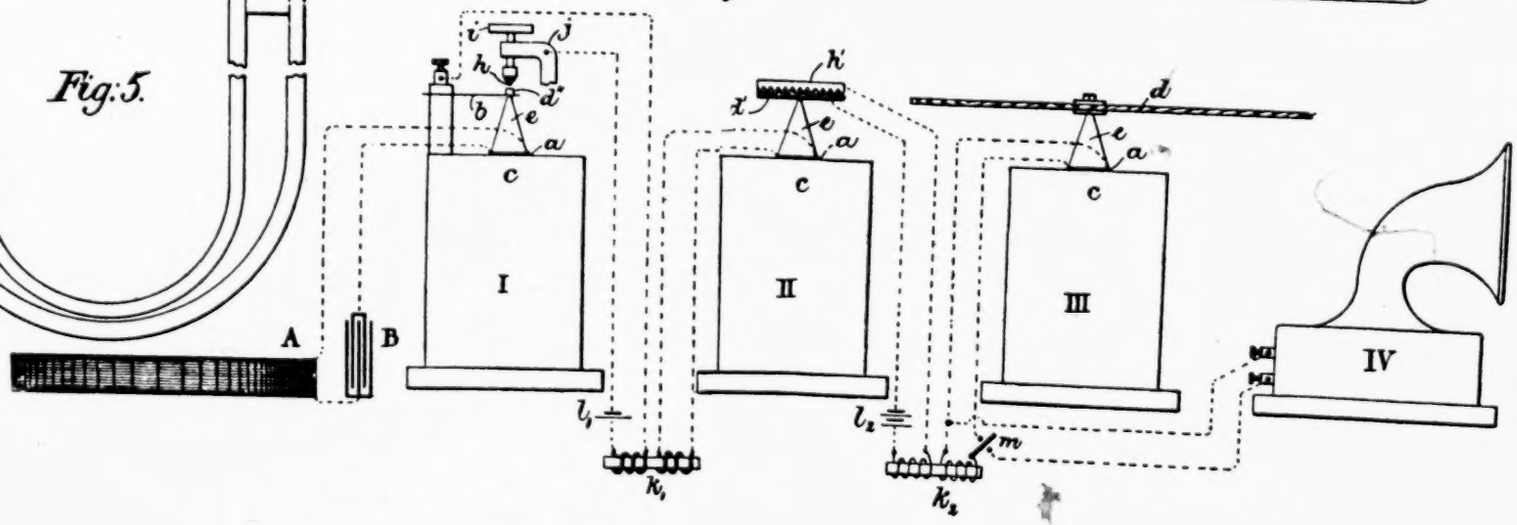


Fig:6.



[This Drawing is a reproduction of the Original on a reduced scale.]

or they may be of metallic ribbon when extra low resistance is desired.

Furthermore for the purpose of a "call," a tone-telephone such as a tuning fork or other persistent vibrator mounted on a sound board may be employed as the last of the series of telephone relays, so as to respond powerfully when alternating currents of its own frequency are excited at the distant station.

For the purpose of discriminating between a number of call stations a combination of differently attuned forks or tone-telephones may be arranged instead of one, so that each shall respond strongly only to its own note and thus indicate the particular station which is desiring to signal. The receiving or collecting circuit may likewise in some cases be attuned to a definite note. At the sending end a battery connected to an acoustic arrangement, such as a reed, or a string or other rapid intermitter or reverser of current, may be used to stimulate a circuit containing both capacity and self induction, so that it shall be thrown into strong electro-magnetic vibration.

Dated this 27th day of April 1898.

A. F. Spooner, 323, High Holborn, London, Agent for the Applicant.

Complete Specification

Improvements Relating to Telephones and to Circuit Arrangements and Relays Therefor

I, Oliver Joseph Lodge, F.R.S., D.Sc., of 2, Grove Park, Liverpool, in the County of Lancaster, Professor of Physics in University College, Liverpool, aforesaid, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The chief objects of my invention are to provide means for the audible detection of extremely feeble fluctuating electric currents, such for instance as may be caused in a closed, or practically closed, circuit, by another very distant circuit supplied with alternating currents; to magnify the telephonic effect of feeble currents by successive specially-designed relays until the sound is sufficient to act as a "call" summoning the operator to attend to receive the

message; to magnify the telephonic effect of speech so that conversation transmitted round one circuit may be heard inductively in a different circuit provided with proper instruments; and generally to improve the conditions under which telephony is carried on so as to magnify every fluctuation of current and thus produce a loud sound from a feeble stimulus for any useful purpose.

For the purpose of detecting or manifesting any feeble alternating or intermittent current, whether excited microphonically or inductively or otherwise, I construct a special kind of telephone or relay, the main features of which are depicted in the annexed drawings. It consists of a coil of insulated wire or metal ribbon a supported freely by an elastic spring b (Figure 3) or by one prong of a tuning fork b^1 (Figure 2) in a strong magnetic field produced by an electromagnet or permanent magnet c of which one pole c^1 is inside the coil while the other pole or keeper c^{11} is outside and surrounding it. The coil is constructed of light materials well cemented or fixed together so as to move as a rigid body, and whenever an alternating current passes round it, it is thrown into bodily vibration, and transmits [fol. 314] these vibrations mechanically to whatever is connected to it. The said coil may be attached in any light and rigid manner to a sound board d (Figure 1) or to the diaphragm d^1 (Figure 7) of a microphonic transmitter, or it may carry a piece of graphite, carbon, or other suitable substance d^{11} (Figures 2 and 3) so that the sound board, the diaphragm, or the carbon, receive the mechanical vibrations.

The object of transmitting the vibrations to the sound board d is to make them directly audible. The object of transmitting them to the microphonic carbon granules or pellet is to actuate a kind of microphonic relay which by throwing into intermittent action the current from a local battery shall greatly magnify the intensity of the originally received disturbance.

The sound-board receiver is depicted in Figure 1, where e is a thin aluminium or other light cone or tripod connecting the vibrating coil a rigidly to the sound board d, which may be of large size and may have a number of similar coils attached to it in various parts. For instance it might form the ceiling or wall of a public hall; and the alternating current originally received by the several coils would in that case be caused by the voice of a speaker directed

towards any form of microphonic transmitter capable of distinct articulation.

In the case of Figure 1 the sound board d, or in the case of Figure 7 the diaphragm d^1, itself constitutes the elastic support of the coil a and dispenses with the necessity of the separate spring such as that shown at b in Figure 3. Only one end of the keeper c^{11} is shown in Figures 1 and 2; the side of it is indicated in Figure 3, and it continues to the other pole of the magnet which it similarly surrounds as shown in Figures 5^a and 5^c. In all these figures, the keeper is supported rigidly from the pole by means of a brass collar and plate f.

A form of magnet is shown in Figure 4 (which represents a plan and elevation respectively) where the keeper c^{11} is a round plate of soft iron pierced with holes for the reception of four poles like c^1 and where c_6 is a bundle of hard steel magnets, joined to the four rods c^1 by an iron base plate c_3. Or else, as an alternative arrangement, the whole is of soft iron and the space g surrounding the central shaft is filled with wire, constituting it an electromagnet. Thus a magnet with four pole pieces like c^1 and four annular air gaps or inter pole spaces a^x to receive four vibrating coils such as a shown in the other figures is produced.

Figures 5 and 5^a illustrate in plan; Figure 5^b in side elevation; and Figure 5^c in vertical section, an alternative form of steel magnet and its keeper. The magnet is one of ordinary horseshoe shape with two poles c and soft iron pole pieces c^1 surrounded by a soft iron keeper c^{11} attached rigidly by the brass collar-plate f to the pole pieces.

The coil a instead of being attached to a metal diaphragm held near the ear, or to a sound board as described, may in the first instance be mechanically attached to the diaphragm of a granular microphone as shown in Figure 7 or to some other microphonic arrangement fed by a local battery and having in its circuit (through a transformer or otherwise) another telephone as shown in Figure 6, which may be either of any usual pattern or of the above described new pattern with vibrating coil. This second movable or trembling coil may thus actuate by mechanical means another microphone which, through the energy of its relay battery, may powerfully disturb a third telephone,

and this again if necessary a fourth and so on. The whole arrangement is depicted in Figure 6; where the concluding telephone of the series is indicated in two alternative forms either of which may be switched on by the switch m. By this means any required degree of magnification can be obtained, for I find that a coil thus moving as a whole in a magnetic field (otherwise maintained) is very suitable for communicating its tremors to a microphone-transmitter whether of special or of any customary form; being much more effective for this purpose than the ordinary iron diaphragm receiver which vibrates in parts and is under considerable constraint. The final instrument of the series is usually a loud speaking iron disc or diaphragm telephone of some ordinary pattern suitable for imparting vibrations to the air and so on to the ear; or it may be an electro-[fol. 315] dynamometer or a Langdon-Davis phonophoric receiver, or other instrument, for example, that shown in Figure 8, whereby the vibrations are enabled through a relay to work Morse or other telegraph instruments.

I may use this plan of magnification as a call, or as a receiver in magnetic telegraphy, but it is obviously applicable to other useful purposes such as magnifying a speaker's voice by distributing it to various parts of a large hall.

The main features of the microphonic relay or magnifying telephone are shown in detail in Figures 2 and 3, where the vibrating carbon d^{11} is in light contact (it is shown separated in the figures for clearness) with another piece of carbon or other electric conductor h which is firmly held and adjusted by a thumb screw i working in a suitable support j. It is to be understood that the support j and the spring b or the prong of the tuning fork b^1 are to be connected to a local battery circuit which shall also be connected either directly or through a transformer with the coil of another second receiving telephone. This second telephone thus supplied with intermittent or alternating currents of magnified intensity may be a telephone of ordinary pattern, or it may be a vibratory coil telephone like Figure 1, or it may be another relay telephone like Figures 2 and 3 or like Figure 7 which then in turn magnifies further and operates another telephone, and so on.

Figure 6 serves to show the connexions for such a series of magnifying telephones, or telephone relays. In that

figure the coil and condenser indicated at A B represents subject matter described in the Specification of another Application for Letters Patent filed by me and numbered 29,505 dated 13 December 1897, though it may be replaced by any other transmitting or collecting apparatus; for instance this original current fluctuator might be an ordinary microphonic transmitter operated by the voice. The Roman numerals I, II, III and IV represent a possible arrangement of the receiving and magnifying apparatus. No. I is a relay telephone like Figure 2 or Figure 3 with a vibratory coil varying the microphonic contact of the carbons d^{11} and h, one of them being supported by the spring b. No. II is another relay telephone like Figure 7 adapted to stronger currents, with its vibratory coil varying the microphonic contacts in a granular transmitter with its thin carbon diaphragm d^1 and carbon base h^1. No. III is a loud-speaking telephone consisting of a vibratory coil and sound board, like Figure 1. No. IV represents another form of loud-speaking telephone, alternative to the last, where a vibratory diaphragm disturbs the outer air through a concentrating funnel. The magnet in Nos. I, II and III is supposed to be an electromagnet shaped like Figure 4, but with only a single air gap surrounding the central shaft C_0 which is wound with a magnetizing helix and surrounded by an outer iron cylinder instead of the four rods c^1 of that figure. The magnet of No. IV is supposed to be more like the horseshoe pattern of Figures 5 to 5^c; or it may be any known form of loud-speaking telephone. Electrical connection between I and II and between II and III is effected by means of the transformers k_1 and k_2; l_1 and l_2 are the local batteries, of which l_2 is permissibly stronger than l_1, because of the many contacts in the granular microphone d^1 h^1. Instead however of the speaking telephone No. III a modification called a "call telephone" may be employed. The design of this is depicted in Figure 8 where the coil, suspended as before in a field due to the magnet c by the rigid light connector e, operates the limb of a spring or of a tuning fork b^1 clamped to the pillar n and carrying an adjustable counter-poise o for the purpose of equalizing the load on both prongs, and also permitting a slight range of tuning. The studs p and q are platinum, lightly in contact, the upper one q being held by the thin spring r and adjusted by the thumb screw i. The pillar j supporting this spring is insulated, as for in-

stance by the ebonite s, and thus n and j can be connected to a local battery circuit containing an ordinary relay the tongue of which is just held over by the current across the junction p, q so long as that junction is undisturbed. But directly the fork trembles, the contact between p and q is practically broken or greatly enfeebled, by the dancing of the light spring r on the heavier spring b^1, and accordingly [fol. 316] the tongue of the relay in circuit with p, q (that is with n, j) mover over and completes the circuit of an ordinary electric bell or it may work a Morse instrument.

For the purpose of discriminating between a number of "call" stations a combination of differently attuned forks or tone telephones may be arranged, instead of one, so that each shall respond strongly only to its own note and thus indicate the particular station which is desiring to signal. The receiving or collecting circuit may likewise be attuned to a definite note, as detailed in the specification of my said prior application.

Whether the spring b or the tuning fork b^1 is employed as the elastic support for the coil in any case is optional, but whenever precision of tuning is desired, so that the receiver shall respond to one particular frequency of distant impulses and not to others, I prefer the tuning fork; and in that case it would be preferable to make Nos. I, II and III of Figure 6 all tuning-fork telephones. But where many notes, or where speech is desired to be received and magnified, then either a spring or a diaphragm or some other elastic support can be used. Further I find that a microphonic receiver, I shunt the latter out by a self-induction or ing through it; so whenever the receiving telephone is of too high resistance to permit this strength of current to flow in simple circuit with it I shunt the telephone by means of a low resistance self-induction or choking coil which conducts the main part of the steady current but diverts the variations of current through the telephone. On a long line a transformer is the natural mode of achieving this object but on a short or purely local line I find the choke shunt preferable.

To enable a fairly strong current to be sent through a microphonic transmitter without over-disturbing a telephonic receiver, I shunt the latter out by a self-induction or choke coil t, as indicated in Figure 9, where the transmitter h^1 is shown operated by one of the vibrating coils a as in

Figure 7 but its telephonic receiver is shunted by the coil t, whereby the steady current is mostly conveyed, while its rapid fluctuations mostly go through the telephone. To assist the fluctuation to go through the telephone, I place a condenser u in series with it as shown in Figure 10. This has the effect of strengthening oscillations of some particular frequency in especial, and of all frequencies not too far removed from that.

It is to be understood that the microphone transmitter may be worked by the voice or by any other usual arrangement, and is not limited to the disturbance by attached coils.

Whenever a temporarily inoperative microphone is in circuit with a telephone (as for instance the ordinary transmitter belonging to a local receiver during the reception of a distant message), an accidental noise, a grating or hissing, is usually going on in the telephone. This can be diminished by shunting the telephone with a condenser v, as indicated in Figure 11, an arrangement which is advantageous in some forms of ordinary voice telephones, as it diminishes the disturbing noise from the local transmitter while the desired message from a distant transmitter is being listened to.

This and the other methods mentioned, though specially applicable to such pure-tone-telephony as is appropriate for Morse signals, can also be used with speech-telephony under certain conditions.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:

1. A telephone having a coil freely supported in a magnetic field upon an elastic spring or its equivalent substantially as and for the purposes set forth.

2. In a telephone, the combination of a coil freely supported upon an elastic spring or its equivalent with a magnet one pole of which is inside the coil while the other pole is outside and surrounding it substantially as and for the purposes set forth.

3. The method, substantially as set forth, of attaining forcible mechanical or acoustic vibrations from fluctuating electric currents by a telephone consisting of an elastically [fol. 317] suspended movable coil, suspended in an annular

or other suitable magnetic field, and connected with a sound board, or its equivalent.

4. The method, substantially as set forth, of magnifying feeble mechanical vibrations electrically received by means of a vibrating coil so arranged as to operate a microphone or microphonic transmitter whose current serves to work another telephone.

5. The combination of a series of telephones and microphones connected alternately electrically and mechanically, so that each telephone receives a disturbance electrically from the preceding microphone and passes it on mechanically in magnified intensity to the next microphone, while each microphone receives a disturbance mechanically from the preceding telephone (or in the case of the first of the series possibly from the voice direct) and passes it on electrically to the next telephone of the series.

6. The microphonic relay or magnifying telephone constructed substantially as described with reference to Figures 2 and 3 of the accompanying drawings.

7. A magnet with one or more inter pole spaces each containing a suspended coil of wire arranged to receive fluctuating currents and thereby to be thrown into vibration substantially as described with reference to Figure 4, or to Figures 5, 5^a, 5^b, and 5^c of the accompanying drawings.

8. As a telephonic "call," a light metallic contact in a local relay circuit arranged so that it dances on an elastic vibrator and thereby changes in electrical resistance when the vibrator is excited by means of fluctuating currents sent round an attached coil suspended in a magnetic field substantially as described with reference to Figure 8 of the accompanying drawings.

9. In a telephonic arrangement, the combination of a magnet, a mechanically vibrating coil surrounding one of its poles, a microphone, and a telephone or its equivalent substantially as and for the purposes set forth.

10. In combination, a tuning-fork or reed and a vibrating coil substantially as and for the purposes set forth.

11. In combination, a tuning fork or reed, a vibrating coil and a loose contact attached to the tuning fork for the purpose of operating a relay and so furnishing a "call" substantially as set forth.

12. In a telephonic circuit the choke coil t substantially as and for the purpose set forth.

). 1899. May 4. N:: 9418.
)HI'S Complete Specification.

FIG. 2.

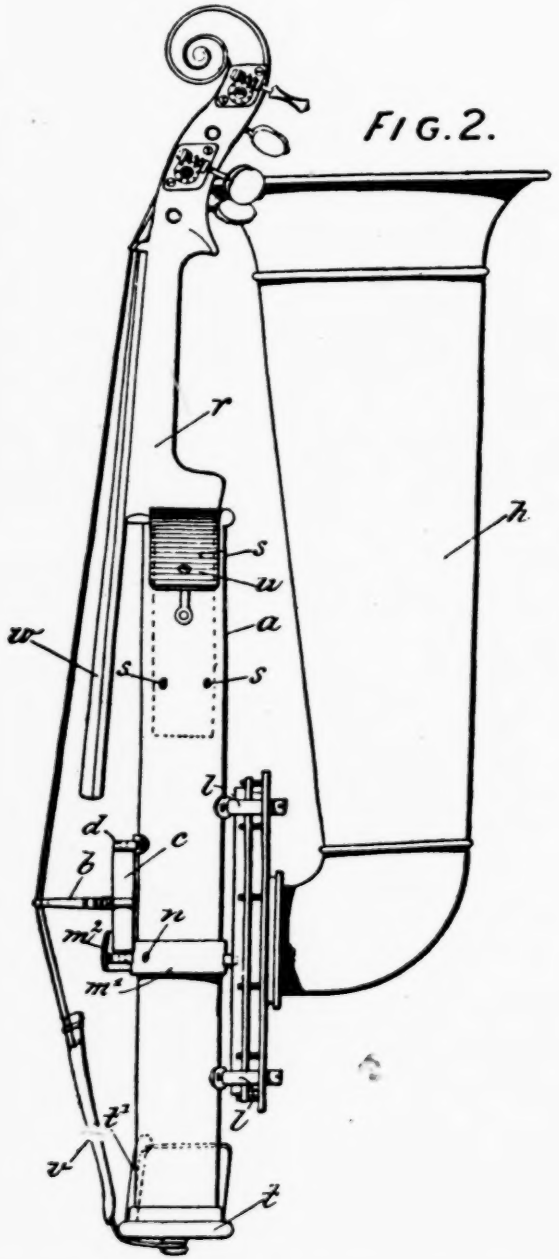


FIG. 4.

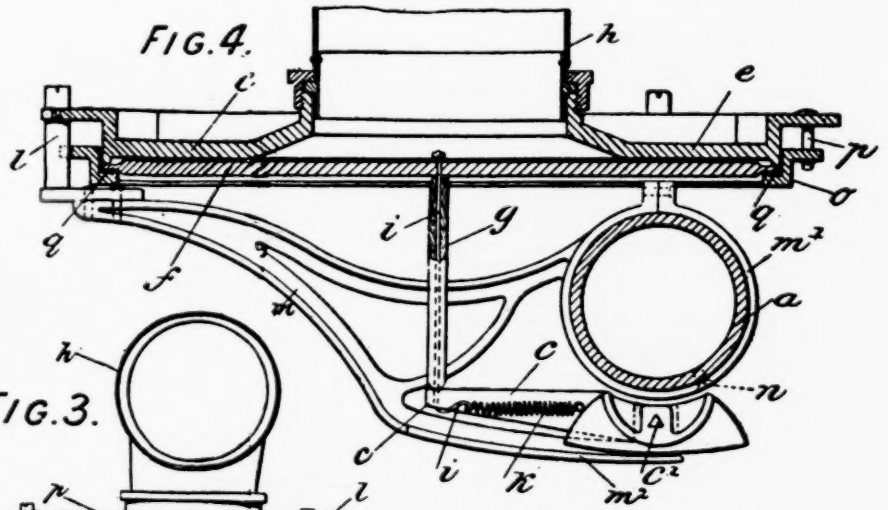


FIG. 3.

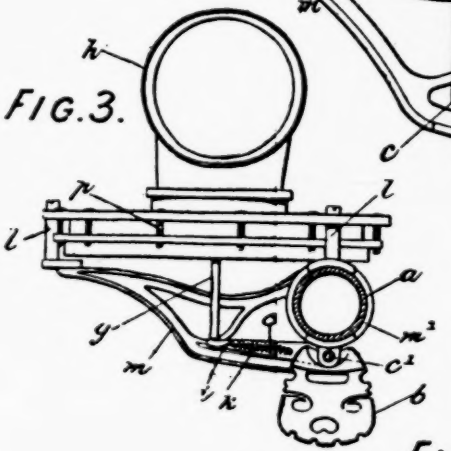


FIG. 5.

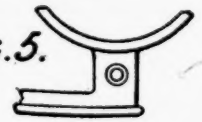


FIG. 6.

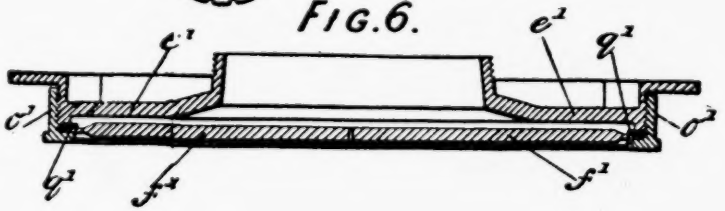
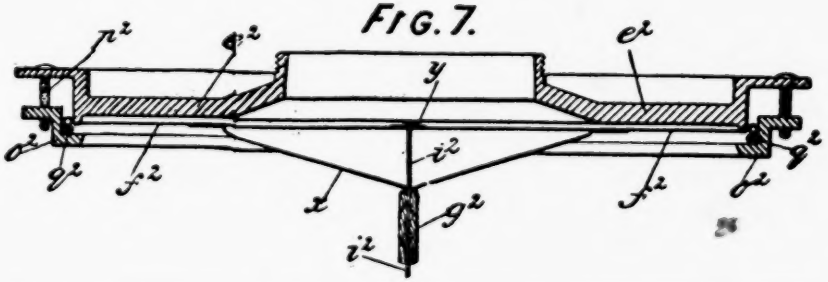


FIG. 7.

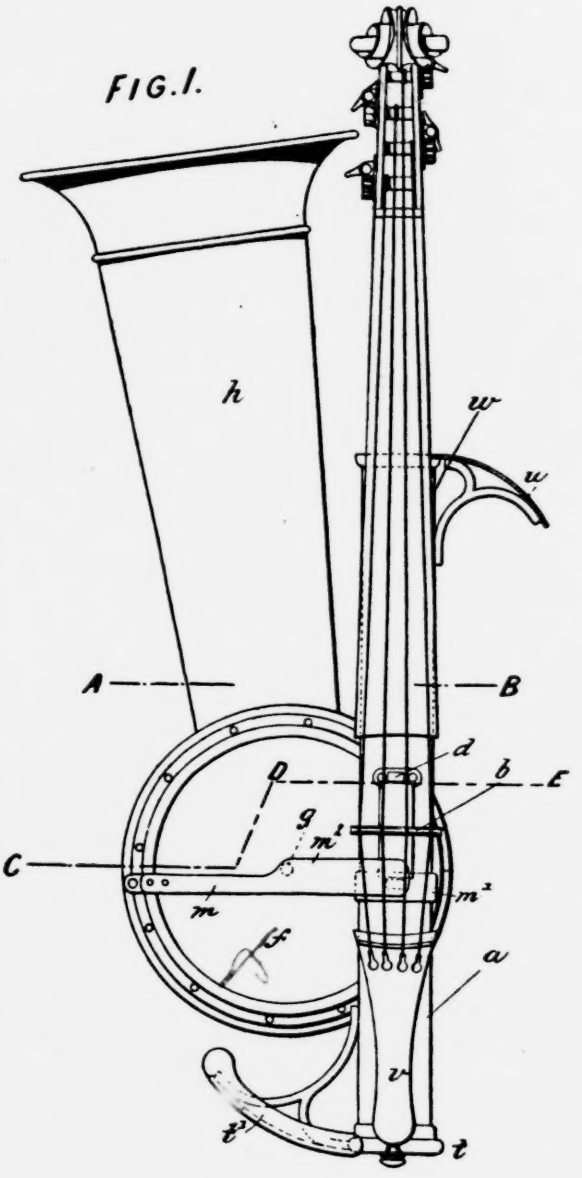


[This Drawing is a reproduction of the Original on a reduced scale.]

A.D. 1899. MAY 4. N° 9418.
STROH'S COMPLETE SPECIFICATION.

3 SHEETS; SHEET 1

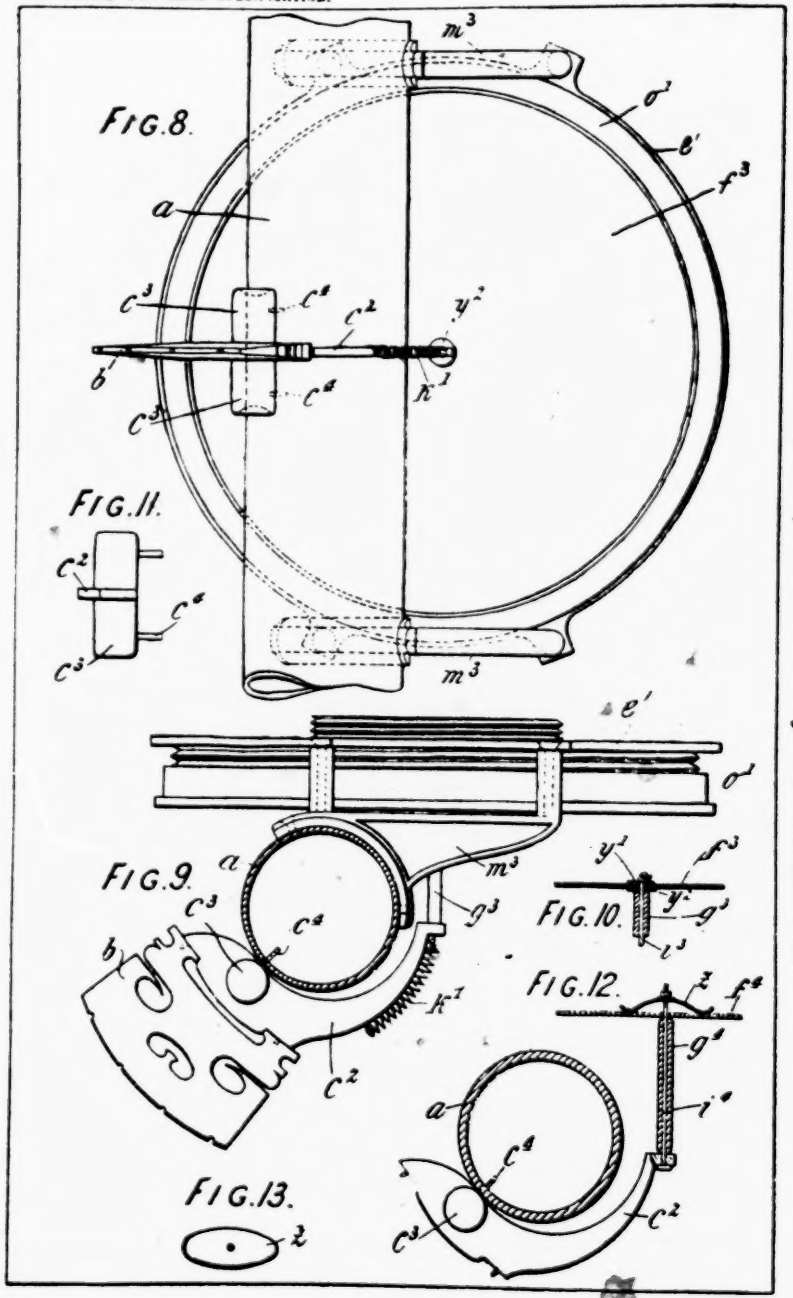
FIG. 1.



[This Drawing is a reproduction of the Original on a reduced scale]

A.D. 1899. MAY 4. N° 9418.
STROH'S COMPLETE SPECIFICATION.

(3 SHEETS)
SHEET 3



[This Drawing is a reproduction of the Original on a reduced scale.

13. In a telephonic circuit the condenser v substantially as and for the purpose set forth.

14. The combination, in a telephonic circuit, of the choke coil t and the condenser u substantially as and for the purpose set forth.

Dated this 13th day of December 1898.

A. F. Spooner, 323, High Holborn, London, Agent for the Applicant.

Redhill: Printed for Her Majesty's Stationery Office, by Malcomson & Co., Ltd.—1899.

(Here follow drawings, side folios 318, 319, 320)

[fol. 321] The circular frame or drum-head which *the* holds the edges of the circular diaphragm, and the distributing cone, are preferably made of aluminium.

Dated this 3rd day of April 1899.

Fairfax & Wetter, Agents for the Applicant

Complete Specification

Improvements in Violins and Other Stringed Instruments

I, John Matthias Augustus Stroh, Electrical Engineer, of 98, Haverstock Hill, in the County of London, do hereby declare the nature of this invention and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement:

This invention relates primarily to a violin, which has a diaphragm or membrane and a resonator, instead of the ordinary violin body or sounding board, but is applicable also to other stringed instruments.

In the accompanying drawings:

Fig. 1 is a front view of a violin embodying my invention; Fig. 2 is a side view of the same; Fig. 3 is a sectional plan along line A—B of Fig. 1; Fig. 4 and 5 represent details of construction on a larger scale, Fig. 4 being a sectional plan along broken line C—D—E of Fig. 1; and Figs. 6 and 7 are horizontal sections representing modifications.

The strings, together with the bridge, finger board, head, neck, and tail piece of the violin are mounted on a suitable tubular body portion a, made of aluminium wood or other

suitable material, preferably in the shape of a tube of circular or square section.

The bridge b is not directly attached to the said tubular body portion, but rests on a transverse rocking lever c adapted to turn on knife edges c^1, the bearings d of which are rigidly fixed to the tubular body portion a, or the bridge and the rocking lever may be made of one piece.

Underneath the frame a and rigidly attached thereto is a circular frame or drumhead containing a diaphragm of wood, glass or other rigid material, or a stretched membrane of parchment or other flexible material.

Fig 4 shows an example of a drumhead e with wooden diaphragm f. Fig. 6 another example, and Fig. 7 shows an example of a drumhead with a membrane f^2 of parchment. Fig. 5 is an end view of one of the knife edge bearings belonging to Fig. 4.

The centre of the diaphragm or membrane is mechanically connected with one end of the rocking lever c by means of a link or other suitable transmitting device, so that the vibration of the violin strings, when bowed, will be finally transmitted to the diaphragm f. The latter may be open to view on one side, while the other is enclosed by a cover or drumhead e having in the centre an opening, against which is attached a resonator or tube h, to augment and distribute the sounds emitted by the diaphragm, in other words to receive and distribute the waves of air caused by the mechanical vibrations of the diaphragm.

The said resonator has preferably the shape of a trumpet as shown, but other suitable forms of resonators may be adopted.

The connection between the long arm of the rocking lever c and the diaphragm may be made in various ways, but I prefer to adopt the arrangement represented by Fig. 4 of the drawings; that is to say, the extremity of the rocking lever c is placed axially above the centre of the dia- [fol. 322] phragm f, and the transmitting device mentioned above has the shape of a tubular rod or link g rounded at the ends, one end abutting against the centre of the diaphragm and the other end against the rocking lever c. A piece of gut i or other suitable cord passes through the centre of the diaphragm, through the link and perforated extremity of the rocking lever, and is attached at one end to the said lever, through the intermediary of a helical spring

k, while the other end is secured to the diaphragm by means of a knot The sprink k is so adjusted, as to keep the cord i always at the required tension, and to prevent any slackness between the rocking lever and the diaphragm.

In the construction represented by Figs. 3 and 4, the drumhead e is mounted on three screw studs l distributed over its circumference; two of these studs being attached directly to the tubular body portion a, while the third is attached to a long arm or open frame m forming at one end a clamping ring m^1 which encircles the frame a and is fixed to the same by a screw n. As shown by Figs. 1 and 4, the open frame m extends above the rocking lever c and has a flange m^2, which covers and protects the said lever, together with spring k and the upper end of the cord i. The edge of the diaphragm f is enclosed by a flanged ring or lid o attached to the drumhead e and rendered adjustable by means of screws p. The edge of the drumhead or disc e which faces the diaphragm f has a projecting rim adapted to support the edge of the diaphragm, which is held between the said rim and an india-rubber packing ring q resting on the flange of the lid o. The wooden diaphragm is preferably reduced in thickness at the edge, as shown.

The tubular body portion a (Figs. 1 and 2) is provided at one end with a hand rest u and connected with the neck r of the violin, which extends into the tube or frame a and is fixed by screws s, while the other end of the frame is closed by a cap t connected with the tail piece v in the usual way and provided on one side with a chin rest t^1; w is an ordinary finger board.

In the modification represented by Fig. 6 the flanged cover or ring o^1 is connected with the drumhead e^1 by a screw joint, instead of having screw studs distributed on its circumference.

In the modification represented by Fig. 7, the vibrations are transmitted from the tubular link g^2 to a flexible membrane f^2 through the intermediary of a distributing cone r, instead of passing directly into the membrane, the said stay g^2 being made shorter and resting with its lower end upon the apex of the cone while the cord i^2 passes through the apex of the cone and through the membrane

The rocking lever, as well as the body portion a, the drumhead e, cover o, distributing cone and supporting arm

m are preferably made of aluminium or of any other suitable material.

If a bow be drawn across the strings, the vibrations of the latter will cause the bridge, together with the rocking lever, to oscillate on the knife edges, and the oscillations of the lever will be transmitted through the link to the diaphragm.

The top of the bridge is therefore an arc of a circle having its centre in the axis of oscillation formed by the knife edges, and the bridge is either made of one piece with the rocking lever, or so connected with same, that all vibrations transverse to the strings will be transmitted to the lever.

The construction represented by Figs. 8 and 9 differs from that represented by Figs. 1 and 2 principally by the shape of the rocking lever c^2 and the arrangement of the diaphragm and resonator.

The rocking lever, instead of being mounted on a pair of knife edge bearings, has a pair of pins c^4 fixed by the hub c^3 (Fig. 11) and passing radially through a pair of perforations in the tubular body a, as shown by Fig. 9.

The lever c^2 is curved, so as to follow the curvature of the body a and to bring the link or stay g^3 nearer to the circumference of the body a.

One end of the transmitting cord i^3 (Figs. 9 and 10) passing through the tubular stay g^3 is attached to the lever c^2 [fol. 323] through the intermediary of a helical spring k^1 while on the other end are mounted a pair of washers y^1 and y^2 holding the diaphragm f^3 between them (Fig. 10)

The edge of the diaphragm is held between the drum-head e^1 and the screw-threaded ring o^1 The drum-head is attached to a pair of brackets m^2 mounted on the tubular body a. The resonator is not shown in the drawing.

The rocking lever c^2 is held against the body a by the pressure of the violin strings acting on the bridge b, and the orifices for the pins c^4 are sufficiently large to allow the necessary rocking motion of the lever c^2.

In the modification represented by Fig. 12, the rocking lever c^2 is connected with the diaphragm f^4 by means of a pin i^4 provided at one end with a bolt-head and at the other with a screw-nut resting on a bent leaf-spring z (Figs. 12 and 13) which abuts against the diaphragm.

It will be understood, that the examples shown by the drawings represent special forms only of my invention, that

the shape and arrangement of parts may be modified, without departing from my invention. My improvements are applicable also to violoncellos, mandolins, guitars and other stringed instruments.

Having now particularly described and ascertained the nature of the said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. A stringed musical instrument, comprising in its construction a bridge supporting the strings, a rocking lever connected with the said bridge and supporting the same, a diaphragm held and supported at the edges and adapted to oscillate in the centre, a transmitting device situated between the extremity of the rocking lever and the diaphragm and adapted to transmit oscillations from the said lever to the diaphragm, a resonator situated in proximity to the diaphragm and adapted to receive and distribute the waves of air caused by the vibrations of the diaphragm, and a body portion adapted to support the rocking lever, diaphragm and resonator, and to connect these parts with the parts holding the ends of the strings, substantially as described.

2. In a stringed musical instrument, in which the bridge supporting the strings is mounted on a rocking lever and the vibrations of the latter are transmitted to a diaphragm, the combination of the rocking lever and the diaphragm, with a link interposed between the extremity of the rocking lever and the diaphragm, and a flexible cord or a wire attached at one end to the said rocking lever and at the other end to the diaphragm, substantially as described.

3. In a stringed musical instrument, in which the bridge supporting the strings is mounted on a rocking lever and the vibrations of the latter are transmitted to a diaphragm, the combination of the rocking lever and the diaphragm, with a tubular link interposed between the extremity of the rocking lever and the diaphragm, and a flexible cord or wire passing through the said tube, one end of the said cord or wire being attached to the rocking lever and the other to the diaphragm, substantially as described.

4. In a stringed musical instrument, in which the bridge supporting the strings is mounted on a rocking lever and the vibrations of the latter are transmitted to the diaphragm, the combination of the rocking lever and the dia-

phragm, with a stay interposed between the same, so as to transmit vibrations, a connecting link or cord connected at one end with the centre of the diaphragm, and at the other end with the rocking lever, and a spring interposed between the rocking lever and the connecting link, or between the latter and the diaphragm, substantially as described.

5. In a stringed musical instrument in which the bridge supporting the strings is mounted on a rocking lever and the vibrations of the latter are transmitted to a diaphragm, a rocking lever turning on knife edges, substantially as described.

6. In a stringed musical instrument, in which the bridge supporting the strings is mounted on a rocking lever and the vibrations of the same are transmitted to a diaphragm, [fol. 324] a circular diaphragm held and supported at the edge and connected in the centre with the said rocking lever, substantially as described.

7. In a stringed musical instrument in which the bridge supporting the strings is mounted on a rocking lever and the vibrations of the latter are transmitted to a diaphragm, the combination of the said diaphragm with a trumpet-shaped resonator adapted to receive and distribute the sound waves produced by the vibrations of the diaphragm, substantially as described.

8. A stringed musical instrument constructed and adapted to operate substantially as described and illustrated by the drawings, Figs. 1 to 13.

Dated this 31st day of January 1900.

Fairfax & Wetter, Agents, 37 and 39, Essex Street, Strand, London.

Redhill: Printed for Her Majesty's Stationery Office, by Malcomson & Co., Ltd.—1900.

(Here follows drawing, side folio 325)

[fol. 326] Complete Specification

Improvement in the Diaphragms of Phonographs, Musical Instruments, and analogous Sound-producing Recording or Transmitting Contrivances.

I, John Matthias Augustus Stroh, Electrical Engineer, of 98, Haverstock Hill in the County of London, do hereby

A.D. 1901. Feb. 16. N° 3393.
STROH'S Provisional Specification.

1 SHEET

Fig 1

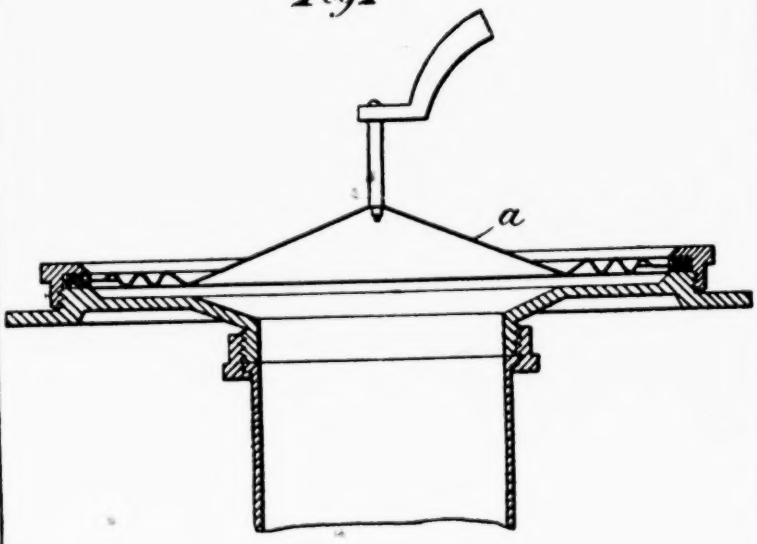


Fig 2.

Fig 3.

[This Drawing is a reproduction of the Original on a reduced scale]

declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The diaphragms of phonographs, graphophones, and analogous sound-producing or transmitting instruments are usually made in the shape of a flat circular disc which is supported at its edges and free to vibrate in the centre.

If such a diaphragm is set in motion by means of a solid body acting on the centre, the amplitude of the vibrations is a maximum in the centre and gradually diminishes towards the circumference, and the waves of air produced by such a diaphragm differ therefore according to their distance from the axis of the diaphragm.

The present invention has for its object, to increase the efficiency and uniformity of the vibrations, and thereby to increase the quality of the sounds, or the accuracy of their reproduction. For this purpose I make the centre of the diaphragm rigid by giving it the shape of a cone having its apex at the point where vibrations are imparted to the diaphragm or transmitted by the same, while the annular portion between the base of the cone and the edge of the diaphragm may be flat or corrugated, the number and depth of the corrugations depending on the nature of the diaphragm and on the effect desired. When the vibrations are imparted to the diaphragm from the centre, the conical part will move up and down as a whole, without materially altering its shape, while the corrugated part yields to each movement of the cone, and as the cone occupies preferably about two-thirds of the diameter of the diaphragm, a larger stratum of air will be set in motion, or the vibrations will be more uniform than in the case of a flat diaphgram. The concentric corrugations of the rim facilitate the motion of the cone in the direction of its axis, while preventing or impeding vibrations in any other direction, which accidental or irregular vibrations are supposed to be the cause of impure sounds. The diaphragm may be made of metal, ebonite, celluloid, or other suitable material, and the most suitable thickness should be ascertained by experiments.

This invention is applicable to phonographs, graphophones, and other instruments, in which the production of sound depends upon the vibration of a diaphragm, or where a diaphragm is used for transmitting vibrations of a solid

body to a stratum of air, for instance, in the violins or other stringed instruments described in my Patent Specification No. 9,418 of 1899.

According to the present invention the diaphragms of violins and similar stringed instruments are made conical in the centre and corrugated at the circumference.

In the drawings filed with the Provisional Specification Fig. 1 is an axial section of a diaphragm embodying my invention, as applied to a violin.

Fig. 2 represents a modification, and Fig. 3 another modification.

Having now particularly described and ascertained the nature of my said invention, and in what manner the same is to be performed, I declare that what I claim is:—

1. In phonographs, graphophones and similar sound-[fol. 327] recording or reproducing instruments, a diaphragm which is conical in the centre and flat or corrugated at the circumference, substantially as described and for the purpose specified.

2. In musical instruments of the violin class, having a sound-producing diaphragm adapted to receive mechanical vibrations in the centre and to communicate them to a stratum of air, the improved shape of the diaphragm, substantially as described and for the purpose specified.

Dated this 6th day of November 1901.

Fairfax & Wetter, Patent Agents, 37 & 39, Essex Street, Strand, London.

Redhill: Printed for His Majesty's Stationery Office, by Malcomson & Co., Ltd.—1901.

(Here follows drawing, side folio 328)

[fol. 329] [U. S. Library, Patent Office, Sep. 19, 1904]

No. 15,060, A. D. 1904

Date of Application, 5th July, 1904—Accepted, 11th Aug. 1904

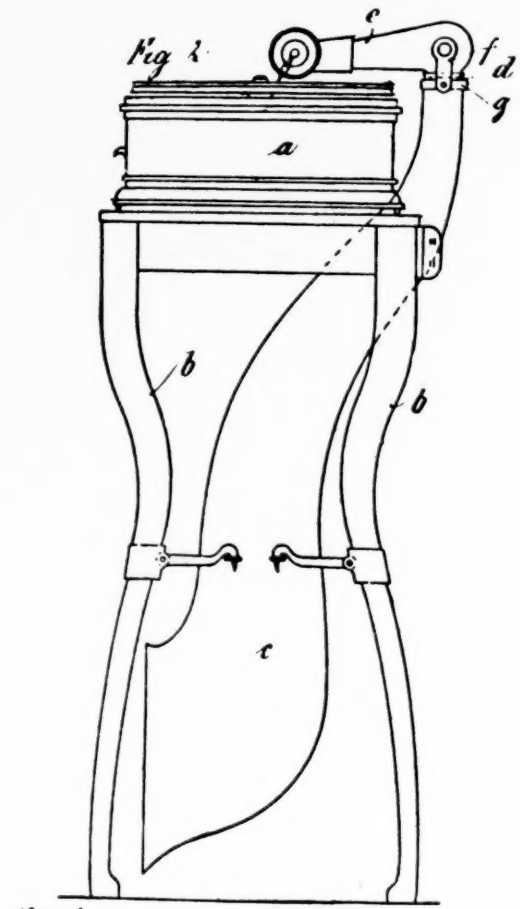
Complete Specification

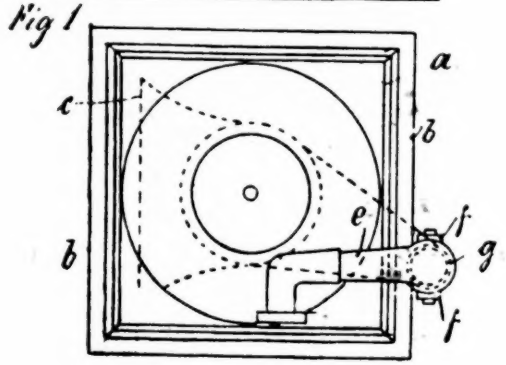
Improvements Relating to Talking Machines

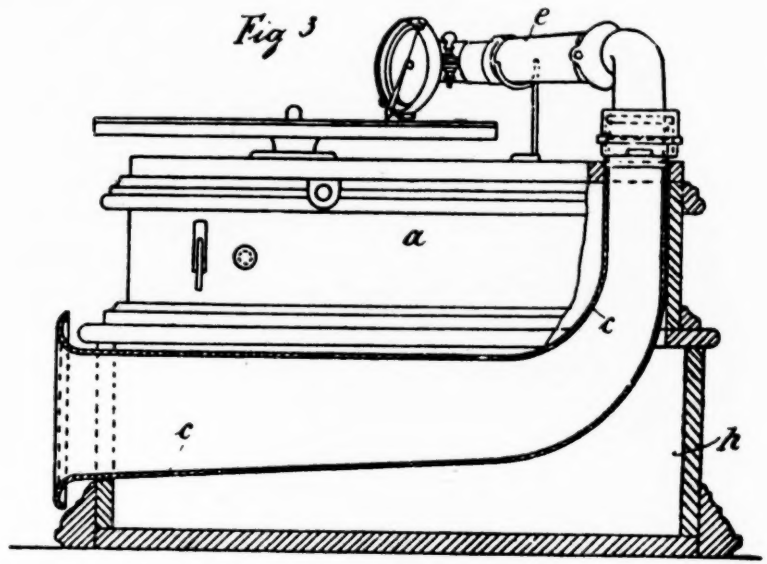
I, Paul Simon, trading as Ernst Holzweissig Nachfolger, of Reichsstrasse 23, Leipzig in the Empire of Germany,

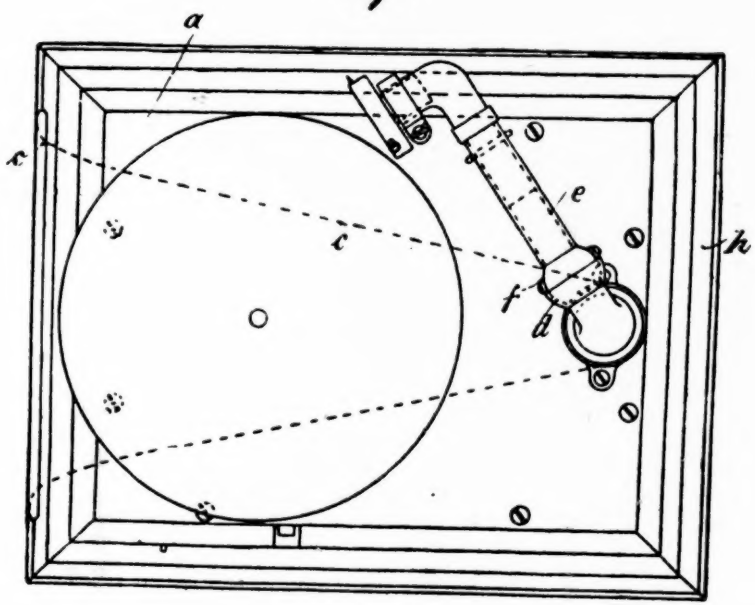
A.D. 1904. JULY 5. N° 15,060.
SIMON'S COMPLETE SPECIFICATION

1 SHEET.









[This Drawing is a reproduction of the Original on a reduced scale]

Manufacturer, do hereby declare the nature of my invention and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement:

This invention relates to phonographs, gramophones, and similar sound reproducing and recording machines, generally known as talking machines.

It is known that in talking machines the reproducing or recording mechanism is so arranged that the trumpet is caused to project either laterally beyond the casing of the apparatus or is directed inwardly over said casing.

Both these arrangements have the disadvantage that the apparatus when in use is very cumbersome, the trumpet particularly being in the way and liable to be knocked, so that the record is frequently damaged by the pin or needle of the sound box.

The object of the invention is to remove these disadvantages.

The main feature of the invention consists in the arrangement of the trumpet below the reproducing or recording mechanism so that it is completely out of the way.

In the annexed drawing two forms of construction of the invention are illustrated.

In the form of construction shown in Fig. 1 in a plan view and Fig. 2 an elevation, the apparatus a is arranged on a table or support b and the trumpet c is so mounted in said table that its mouth is at the lower-part thereof, and within same only the upper narrower part projecting laterally, to a slight extent.

Said upper part of the trumpet c is provided with a circular mouth-piece d in which engages a length of tube e forming a prolongation of the trumpet e and adapted to carry the sound-box.

The tube e is shaped spherically at its end engaging the mouth-piece d so that it is provided with a secure seating therein and a tight connection of both parts is obtained.

On two opposite sides of the spherical portion of the tube e levers f are pivoted, said levers being connected to a loose ring g below the mouth-piece d on the trumpet. By this connection of the tube e and trumpet c it is possible that said tube can move relatively to the trumpet in both vertical

and horizontal directions, at the same time maintaining the necessary tight joint between said two parts.

The tube e can therefore freely follow the movement imparted to the sound box by the record and said tube with the sound box can also be easily placed on and removed from the record.

The form of construction shown in Fig. 3 in sectional elevation, and Fig. 4 in plan is distinguished from the above described construction, by the fact that the trumpet c does not extend vertically downwards for its whole length, but assumes a horizontal direction below the casing a, the latter being placed on a base h closed on three sides and in which the trumpet c is enclosed. The said trumpet is of oval cross-section and its neck which projects through the upper part of the casing a, is bent into a horizontal direction im- [fol. 330] mediately below where it passes through the top of the base h, and terminates at the open side of said base h.

The connection of the trumpet with tube e carrying the sound-box is effected in the manner above described.

The arrangement and form of the trumpet has the advantage that it occupies less space and can be arranged in a comparatively low casing, the whole apparatus being compact, and having the usual appearance; also in both constructions described long trumpets may be used which are of advantage with regard to the tone or sound produced by the apparatus.

Having now particularly described and ascertained the nature of my said invention, I declare that what I claim is:

1. A talking machine in which the trumpet is so mounted in a comparatively high support or table carrying the mechanism that the mouth of said trumpet terminates inside said support near the bottom of the latter, whereas the other narrower end of said trumpet is connected by a spherical joint to a displaceable tubular arm carrying the sound-box substantially as described.

2. A talking machine as described, in which the trumpet of oval cross section is arranged within a base below the mechanism casing in a horizontal direction and terminates with its mouth at the side of said base substantially as described.

Dated this 5th day of July 1904.

Herbert Haddan & Co., Agents to Applicant, 18, Buckingham St., Strand, W. C.

A.D. 1906. APRIL 3. N° 8011.
SZEK & another's COMPLETE SPECIFICATION.

1 SHEET

[This Drawing is a reproduction of the Original on a reduced scale]

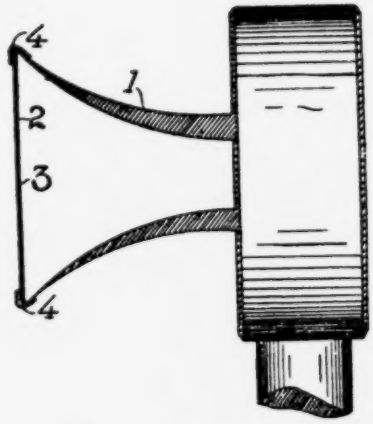


FIG. 1.

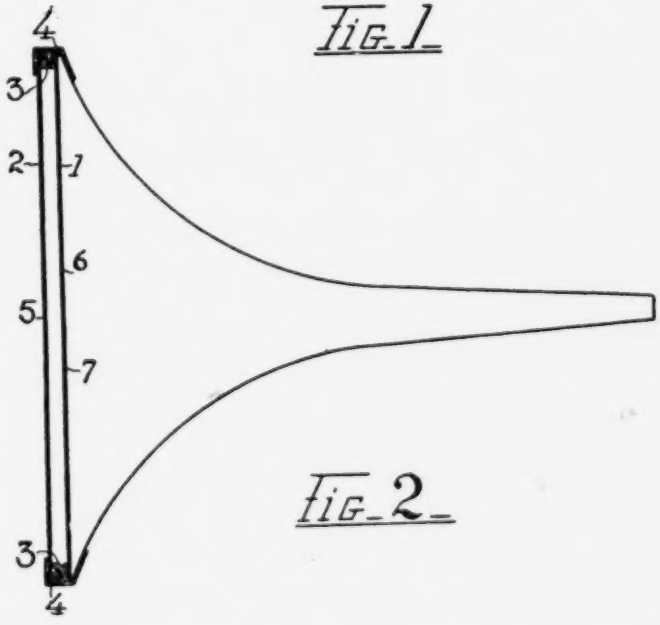


FIG. 2.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1904.

(Here follows drawing, side folio 331)

[fol. 332] No. 8011, A. D. 1906

Date of Application, 3rd Apr. 1906

Complete Specification Left, 20th Apr., 1906—Accepted, 28th Mar., 1907

Provisional Specification

Improvements in and Connected with Sound Horns and the Like

We, Joseph Theodore Szek, Manager of the Crater Cement Company, and Georges Schauli, Electrical Engineer, both of 12 New Oxford Street, London W. C. do hereby declare the nature of this invention to be as follows:

The invention relates to improvements in sound horns, trumpets and the like and has for its object the production, registration or reproduction of sounds in a clearer and more natural manner than is at present possible with existing sound horns or reproducers.

The invention is applicable to all sound transmitting, registering, reproducing and like apparatus including telephones, phonographs, gramophones and like apparatus.

The invention consists in placing a plate of suitable thickness and vibratory power, either plain or perforated at the centre or at various places, with round holes or zig-zag perforations that will increase the power of vibration on the passage of sound waves. These plates which can be made of glass, mica, celluloid, sheet metal or other solids capable of vibration, either flat or corrugated or embossed in any desired manner, are placed on, and fastened to, the bell or opening of the horn, trumpet or the like. To further increase the vibrating powers of these plates, they may be mounted on springs, elastic blocks or even on small sound boxes and several such plates may be placed above or beside each other, with a suitable distance between each so as to

form a kind of sound box, or a series of sound boxes at the end of the horn or trumpet.

Dated this 3rd day of April 1906.

Georges Schauli, Joseph Theodor Szek.

Complete Specification

Improvements in and Connected with Sound Horns and the Like

We, Joseph Theodore Szek, Manager of the Crater Cement Company, and Georges Schauli, Electrical Engineer, both of 12 New Oxford Street, London W. C. do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:

This invention which relates to sound horns, trumpets and the like has for its object the transmission, registration and reproduction of sounds in a clearer and more natural manner than is at present possible with existing sound horns or trumpets receivers, transmitters and the like. It [fol. 333] is applicable to all sound transmitting, registering, reproducing and like apparatus, such as telephones, phonographs, gramophones and like devices or machines.

The improvements which form the invention consist in mounting at the mouth of the sound horn or the like a substantially flat plate, or plates, of suitable thickness and vibratory powers, either plain or perforated at the centre, or at various suitable places, with round holes or zig-zag or other perforation these plates being capable of vibration on being impinged upon by sound waves which are thereby rendered more natural in tone. These plates, which can be made of mica, thin glass, celluloid, thin sheet metal or other suitable materials, are made either flat or corrugated or embossed in any desired manner and are fastened to the mouth, or outside opening of the horn, trumpet or the like, this fastening being effected by rings fitting on the mouth or outside opening of the horn or trumpet or by fastening clips or any other suitable device. The method of fastening may be such that these plates may be put on or taken off at will.

To further increase the vibratory power of these plates, they may be mounted on springs or elastic rings, blocks,

A.D 1907. April 16. N° 8833.
HOUGH'S Complete Specification.
1 SHEET

Fig.1.

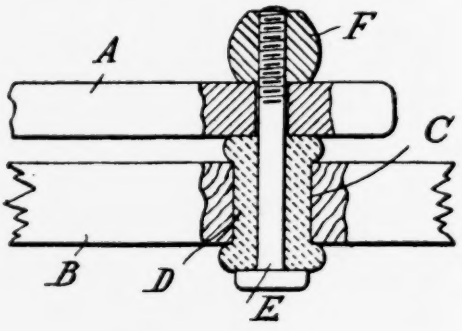


Fig.2.

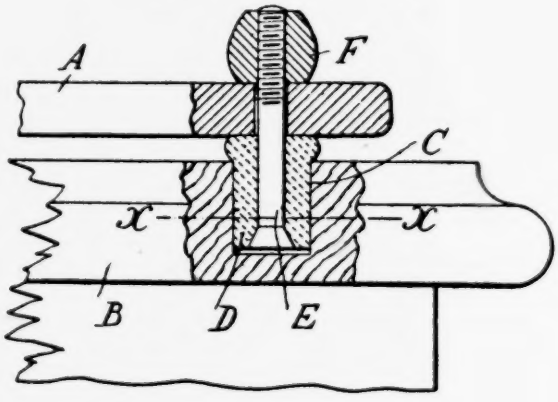
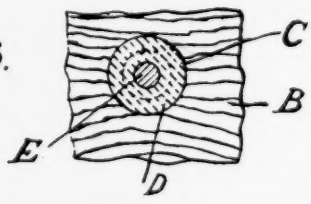


Fig.3.



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small round boxes or the like. Several such plates may be placed above or beside each other, with a suitable distance between each so as to form a kind of sound box or a series of sound boxes at the outer end of the horn or trumpet.

In the case of telephone transmitters or receivers this arrangement has the further advantage of being more sanitary than the existing devices.

In the drawings which illustrate the invention, Fig. 1 shows the invention as applied to a telephone receiver and Fig. 2 as applied to a phonograph or like trumpet.

In Fig. 1 the horn 1 carries the plate 2 with suitable perforations 3, the fastening being effected by a ring 4.

In Fig. 2 two plates 1 and 2 are shown. They are separated by a rubber or other ring 3 and fastened to the trumpet by a ring or clips 4. The plates may be perforated at suitable places such as 5, 6 and 7.

Having now particularly described, and ascertained the nature of our said invention, and in what manner the same is to be performed, we declare that what we claim is:

The combination, with telephone receivers or transmitters or with phonograph, or gramophone sound horns, or the like, of substantially flat plates of glass, mica, celluloid, metals or other suitable materials, these plates being in any suitable manner fastened to the mouth of the horn, trumpet or the like and perforated, corrugated or embossed as may be desired, substantially as described.

Dated this 20th day of April 1906.

Joseph Theodor Szek, Georges Schauli.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1907.

(Here follows drawing, side folio 334)

[fol. 335] No. 8833, A. D. 1907

Date of Application, 16th Apr., 1907—Accepted, 26th Sept., 1907

Complete Specification

"Improvements in the Mounting of Phonographs and like Machines"

I, James Edward Hough, Manager of the Edison-Bell Consolidated Phonograph Company Limited of 39 Charing

Cross Road, London, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:

When mounting a phonograph or like machine on a box or casing it has been customary to insert a rubber or like washer between the metal base and the top of the box or casing, the parts being held in position by screws, and it has also been proposed to partially surround the screws with rubber both for phonographs and for other purposes, and where such rubber is expanded by compression in a closed space it assists in holding the parts together, in both cases the object has been to prevent the vibration being transmitted to the box or casing which otherwise gives out sound interfering with that produced from the phonograph record.

Where the screws touch the metal base and also the box or casing it is found that such screws also transmit the vibration notwithstanding the interposed washers and yet it is necessary for winding or carrying purposes that the parts should be securely held in their relative positions.

According to the present invention it is proposed to so connect the parts that the screws or pins will only touch the metal base or the box or casing and not both and to secure the parts in their relative positions by the expansion in a confined space of the rubber or other elastic insulating material employed in a manner somewhat analogous to that employed for stopping bottles with rubber rings between two hard faces brought together by a screw or lever.

In the accompanying drawings are shown two forms which the invention may take;

Figure 1 showing the connecting bolt as passing completely through the box or casing, while

Figure 2 shows it as in a recess therein, and

Figure 3 is a plan view on line x x.

In said drawings A is the metal base on which the phonograph or like machine is mounted. B is the box or casing provided with openings or recesses C adapted to receive the rubber or like packing D when in its unexpanded condition as when resting freely on bolts E.

In Figure 1 the packing or insulating is shown as being longer than the thickness of B so that as nut F is screwed

A.D. 1908 JAN. 18. N° 1194.
CURTEIS' COMPLETE SPECIFICATION.

1 SHEET

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FIG 1

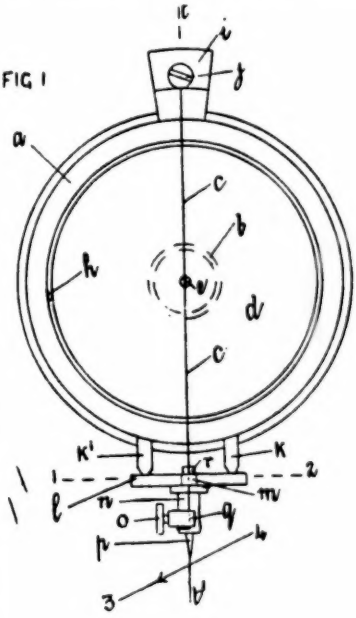


FIG 2

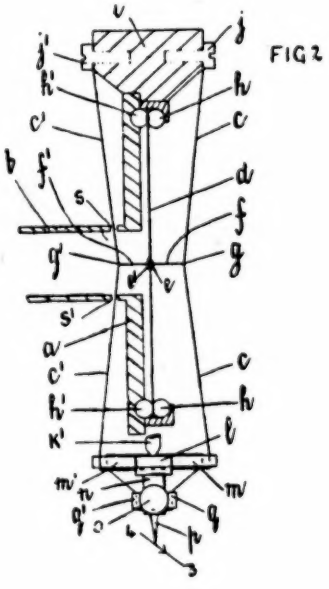


FIG 3

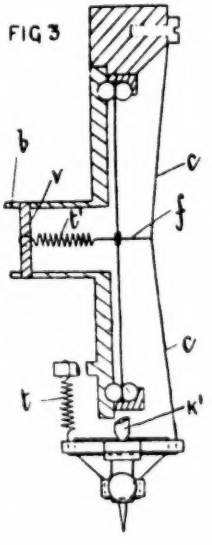


FIG 6

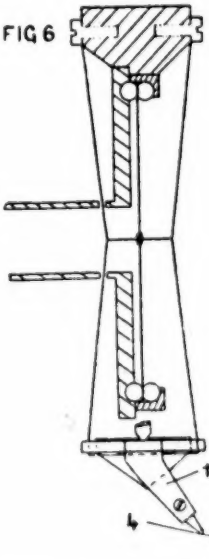


FIG 4

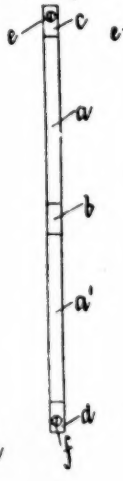
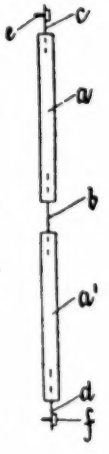


FIG 5



down bolt E, not only is D expanded by compression in opening C but what are practically washers are formed between A and B and between the head of the bolt and B.

In Figure 2 the same result is attained as between A and B while the expansion of D in C is amply sufficient to secure the parts firmly together any drawing up of the bolt E causing its head to cease making contact with B.

It would of course be possible to mould the rubber or like material with one or even with both flanges but by adopting the method described the effect can be attained by simply cutting off sections of tubing adapted to normally just fit the opening C and to make fairly close contact with the [fol. 336] bolt or pin employed, and it is obvious that instead of expanding it in the casing it may be expanded in the metal.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:

1. In the mounting of phonographs and like machines securing the base to the box or casing by bolts or pins in part surrounded by rubber or other elastic material adapted to be expanded by compression and insulate while binding the parts together, substantially as and for the purposes set forth.

2. The improvements in mounting phonographs and like machines, substantially as described, and as illustrated in the accompanying drawings.

Dated this 16th day of April, 1907.

Philip M. Justice, 55 & 56 Chancery Lane, London,
Chartered Patent Agent, for the Applicant.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1907.

(Here follows drawing, side folio 337)

[fol. 338] to the plane of the diaphragm offers a greater advantage in that it is very rigid and resists sag or flexure in a plane parallel to the diaphragm, and all the flexure is constrained to take place in the proper direction, namely at right angles to the plane of the diaphragm.

It is not essential in carrying out this invention to fix the sagging member to the diaphragm at a point half way between its extreme supports, but the fixing may be effected at any point in the length of the sagging member. Also it is not essential to effect the fixing at the central point of the diaphragm, but this may take place at any point on the diaphragm. If required also any number of sagging members may be applied to one diaphragm, and in the case of semiflexible or "rigid flexible" members it is not necessary to stretch them tightly between the supports but they can be stretched or laid between the supports without tension.

A modified form of sound box according to this invention could be constructed having two or more sagging members in series. For example if two are used the sagging of one of the members could move the supports for the other member which actuates the diaphragm.

Such a construction might be useful to get an increased amplitude of vibration of the diaphragm.

Dated the 22nd January 1908.

Arthur F. R. Curteis.

Complete Specification

Improvements in Sound Boxes for Talking Machines and the Like

I, Arthur Frederick Russell Curteis of 80, Blenheim Crescent, Notting Hill, London, W., formerly of 99 Queens Gate, London, S. W., Electrical Engineer do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:

The object of this invention is to provide improved means for transmitting the vibrations recorded on talking machine records to the diaphragm of the sound box belonging to the talking machine, or, conversely of transmitting the movements of the diaphragm which are due to the sound waves impinging thereon, to the needle or other suitable device or producing on the record an alternating trace or scratch or indentation corresponding in amplitude and frequency to the sound waves it is desired to record.

The invention may be applied to the sound boxes of any kind of talking or sound recording machine with which

such boxes are used, as for instance to those of gramophones using records on which the sound waves are recorded in the usual transverse manner, or to those of phonographs using records on which the sound waves are recorded by means of the usual indentations having varying depths.

The invention depends upon the principle that an intermediate part of a more or less flexible wire, string, rod, strip or the like, which is stretched or laid between and fastened at its two extremities to two supports, can be caused to increase its sag or bend when the supports are caused to come nearer together and vice versa.

By taking advantage of the foregoing principle, it is possible, whilst still maintaining the usual ratio of magnification between the amplitude of the recorded sound wave and that of the corresponding movement of the diaphragm, to [fol. 339] make the vibrating parts so light, and with such small moments of inertia, whilst still preserving the necessary rigidity, that a more truthful reproduction or recording of the sound is obtained. If on the other hand an increased volume of sound is desired, this may be secured by suitably proportioning the several parts and the quality of the sound will still be as good as with ordinary sound boxes giving a smaller volume of sound.

Fig. 1 shows in front elevation by way of example a sound box suitable for a gramophone constructed with sagging members according to this invention.

Fig. 2 shows a section of this sound box through the line t t' in Fig. 1. The lower parts and stylus comprising the supporting pins, base, lever arms, needle-holder and needle are however shown in side elevation.

Fig. 3 shows by way of example a view corresponding to Fig. 2 of another construction of sound box according to this invention.

Figs. 4 and 5 show by way of example in front and side elevation respectively a sagging member which is partly rigid and partly flexible and which will be hereafter described.

Fig. 6 shows by way of example a view corresponding to Fig. 2 of a sound box specially adapted for use with machines for phonograph or indented records.

Referring to Figs. 1 and 2, a represents the frame of the sound box and b a tube for supporting the box and for conducting the sound waves to or from a trumpet or the like. d represents the diaphragm which can be made of mica or of other suitable material. The edges of the diaphragm are clamped in the frame a between the two hollow rubber rings h and h'. The wire f f' passes through the centre of the diaphragm and also through the two small washers e and e' on either side of the diaphragm, and is soldered to these washers in such a way that the latter grip the diaphragm firmly between them. i is a block of aluminium or other suitable material which is fixed to the top of the frame a and the screws j and j' on either side of the block serve to clamp and tension the two sagging wires c and c', the latter of which passes through two small holes s and s' in the tube b. The sagging wires c and c' are each divided into two approximately equal portions, and the intermediate points g and g' thus obtained are soldered to the two ends of the wire f f'. The stylus or vibrating lever or member consists of the base l, the lever arms m and m', the needle holder or lever arm n with the needle p, and the needle clamping screw o. The conically pointed ends of two supporting pins k and k' which are fixed at their other ends in the frame a project into two corresponding conical depressions or centre punch holes in the base l, in such a way that the said base together with the arms m and m', the arm n and the needle p, can rock on an axis 1, 2 corresponding to a line drawn through the pointed ends of the two pins k and k', but cannot move with respect to any other axis.

The two sagging wires are in this case stretched fairly tightly between the supports j, m and j', m', and due to the length of the wire f f' the wires c and c' are each caused to sag slightly towards the diaphragm d. The wires c and c' are arranged to have equal tensions, and the pointed ends of the pins k and k' are thus caused to press tightly into the corresponding depressions in the base l and the whole stylus is held quite firmly and in a symmetrical position with respect to the diaphragm d without any other support or fixing being necessary.

A special feature of this construction of sound box is the possibility of obtaining a stylus which is very light and also very rigid.

The arms m and m' each have two small holes drilled near their outer extremities, and a small hole is also drilled at each of the points q and q' of a boss on the needle holder n. A wire is passed through each of the inner holes in the arms m and m', through the holes at q and q' in the boss and round the needle holder n, and having been suitably tensioned is passed along the diaphragm side of the arms m and m' and its two ends are clamped under the head of a small screw r [fol. 340] let into the centre of the base l. The arms m and m' are in this way braced so that they scarcely have to withstand any bending moment but only a plain compressive stress, and they can therefore be made very light. The sagging wires c and c' are in reality only one wire, since at the stylus end the wire c passes through the hole in the outer extremity of the lever arm m, then passes round or through the needle holder n close under the arms m and m', and afterwards through the hole in the extremity of the arm m' from which it emerges as the wire c'. By reason of the friction of the wires in the holes the former cannot slide in the latter, but behave for all practical purposes as if they were clamped with screws. A further advantage, making for lightness without the sacrifice of rigidity, is the absence of all soldered or brazed joints in the stylus, as it is then possible to construct the latter of some light material such as aluminium which does not readily take solder.

The action of this sound box is as follows:—As the sound groove on the gramophone record travels along under the needle in the direction of the line 3, 4 Fig. 1, as indicated by the arrow head, the needle oscillates from side to side round the axis 1, 2. When the needle moves to the left in Fig. 2 the arm m moves downwards and causes the supports for the wire c to get further apart. The point g is thus dragged outwards to the right and pulls the centre of the diaphragm d along with it. The arm m' has at the same time however moved upwards, causing the supports for the wire c' to come nearer together, and the wire c' is therefore eased sufficiently to allow the point g' to be pulled over to the right by the traction at the point g. As soon as the needle moves to the right the reverse action takes place, the wire c' now becoming the tractor at its point g' and the centre of the diaphragm is pulled to the left.

If desired the small holes s and s' in the tube b may be covered over by washers of cloth, rubber or other suitable

material. The wires c and c¹ may also be firmly clamped by screws or other means at the outer extremities of the arms m and m¹, instead of passing through the small holes in the said arms. Moreover the inner holes in the outer extremities of the arms m and m¹ of the stylus and the bracing wire which passes through these holes may be dispensed with so that there is no bracing, or alternatively the bracing may be obtained by leading the wire c, after passing it through the hole in the arm m, through the holes q and q¹ and then to the hole in the arm m¹ from the other side of which it emerges as the wire c¹. The holes q q¹ can be done away with and the wire threaded through a hole in the side of the holder n if desired.

Fig. 3 shows by way of example another construction of sound box in which only one sagging wire is used. This construction is similar to the one explained above with reference to Figs. 1 and 2, with the exception that a spiral spring t for balancing the pull on the stylus of the sagging wire c takes the place of the sagging wire c¹, and another spring t¹ which is fixed to a pin v passing through the tube b acts to pull the diaphragm to the left when an increase of sag in the wire c allows this to be done. The action of this modified sound box will be clear without further explanation, and it will also be clear that the combined pull of the sagging member and of the spring t holds the stylus securely against the supports k and k¹.

The sagging members, according to this invention, may be constructed in a variety of patterns. For example, instead of wires, thin strips of metal or other material may be used with their flatness parallel to the plane of the diaphragm. As a strip member would not crumple up as easily as a perfectly flexible member when the supports came nearer together, it would be possible to construct a sound box with such a strip member on the lines of Fig. 3, but without the spring t¹. The wire or rod f would however in this case have to be capable of with standing compression as well as tension, and different arrangements for support- [fol. 341] ing the stylus might be necessary. Moreover any semiflexible member can be used in this manner.

Figs. 4 and 5 show two views in front and side elevation respectively of a sagging member according to this invention which is partly rigid and partly flexible. It consists of two rigid round bars a and a¹ connected together by a

flat strip b with its flatness parallel to the plane of the diaphragm. The flat strip b is fixed at its centre either directly or indirectly to the diaphragm of the sound box. Flat strips c and d with their flatness parallel to the plane of the diaphragm are fixed to the outer extremities of a and a' and are secured to the supports in any convenient way, such as by means of screws e and f. The action of such a sagging member will be clear without further explanation.

Sound boxes, as already described with reference to Figs. 1, 2 and 3 of the drawings, can with suitable attachments be used with either transverse or indented records, but if used with gramophone or transverse records the sound grooves on the latter would travel, for example, parallel to the plane of the paper along the line 3, 4 in Fig. 1 and in the direction of the arrow head. The depth of the grooves in the thickness of the record would also be at right angles to the line 3, 4 and parallel to the plane of the paper.

If the sound boxes are used with phonograph or indented records the sound grooves would travel, for example, as indicated by the line 3, 4 and the arrow head in Fig. 2, and the needle should be replaced by the usual jewel or sapphire point.

It may be desirable to modify the construction of the sound boxes as previously described in order to adapt them easily to machines for use with phonograph or indented records. Fig. 6 shows by way of example a sound box constructed on the same lines as that described with reference to Figs. 1 and 2, but in which the jewel holder n is bent out of the symmetrical position. The line 3, 4 and the arrow head indicate the direction of travel of the sound groove.

It is obvious that sound boxes having a sagging member or members according to this invention can be made which differ more or less in construction from those already described with reference to the drawings. For instance a system consisting of any number of sagging members may be used to actuate or to be actuated by one diaphragm or a system of two or more sagging members can be used in series. With a system of two such members in series the sagging of one can be arranged to move the supports for the other and the sagging of the latter can actuate the diaphragm of the sound box. Moreover I may use the sag-

ging members for actuating the compressed air valves which are sometimes used in sound boxes for reproducing sound instead of the diaphragm, and I wish the word diaphragm in my specification and claims to be read in this sense also.

Also the stylus may be held against its pivots or supports by devices which do not depend for their action on the tension of the sagging members, and the supports may take the form of knife edges instead of the conically pointed pins, and may engage suitable grooves in the base I. A pad or the like of cloth, rubber, or similar material may be arranged to bear lightly, by spring pressure or otherwise, on the sagging members, in order to prevent the metallic ringing sound which can sometimes be noticed.

I am aware of the arrangement described in Specification Number 7080—94 with reference to Figures 7 and 8 of the drawings, in which a double cord transmits the sound vibrations, directly through a ring D^5 between the stylus and the diaphragm, and in which two springs or weights D^6 are used in conjunction with the ring, partly to adjust the pressure of the stylus on the record, and partly to allow a margin for irregularities in the phonogram other than those due to the sound. My specification however does not refer to means for obtaining these two latter adjustments, and I do not claim phonograph sound boxes constructed in this manner.

[fol. 342] Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. In sound boxes for sound reproducing or recording machines the use of a sagging member or members substantially as described.

2. In sound boxes for sound reproducing or recording machines the use of two sagging members or systems of members one of which is connected to one side of the diaphragm and the other to the other side, to actuate the diaphragm or to be actuated by it substantially as described.

3. In sound boxes for sound reproducing or recording machines the use of a spring or springs in combination with a sagging member or members to react against the pull of the latter on the stylus or on the diaphragm or on both substantially as described.

4. In sound boxes having sagging members for sound reproducing or recording machines utilizing the tension of the sagging members to hold the stylus or vibrating member up against its support or supports in such a manner that no additional means of support for the stylus are necessary substantially as described.

5. In sound boxes for sound reproducing or recording machines arranging two or more sagging members in series so that the sagging of one actuates the supports for another substantially as described.

6. In sound boxes as claimed in Claim 3 arranging the sagging member or members and the spring or springs which react against the pull of the former on the stylus, so that they conjointly hold the stylus against its supports substantially as described.

7. In sound boxes having one or more sagging members for sound reproducing or recording machines a stylus or vibrating lever without soldered or brazed joints substantially as described.

8. In sound boxes having one or more sagging members for sound reproducing or recording machines bracing the lever arms of the stylus by means of wire substantially as described.

9. Sound boxes constructed and arranged substantially as described with reference to the drawings.

Dated the 23rd day of March, 1908.

Arthur F. R. Curteis.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1908.

[fol. 343] No. 17,827, A. D. 1909

Date of Application, 31st July, 1909—Accepted, 11th Nov., 1909

Complete Specification

(A Communication from Excelsiorwerk Fabrik für Feinmechanik, m.b.H., of 121, Niehler Kirchweg, Cöln-Nippes, in the Empire of Germany, Manufacturers)

"Improvements Relating to Talking Machines"

I, Ernst Zappert, of 27, Chancery Lane, in the County of London, Engineer, do hereby declare the nature of this in-

vention and in what matter the same is to be performed, to be particularly described and ascertained in and by the following statement:

This invention relates to encased talking machines of the kind in which the record and sound-box-arm are enclosed in a chamber arranged beneath a second chamber, into which the sound-horn opens and which is open at the front. In the apparatus of this kind heretofore known, it has been suggested to improve the quality of the sounds by means of strings mounted in the open front of said second chamber, which is made shallow.

Now according to the present invention, instead of using said strings, the said second chamber is made of sufficient depth to serve as a resonating chamber and a curved surface or surfaces are employed adjacent to the opening of said second chamber to distribute the sound. This curved surface serves at the same time as a cover for the space in which the record-disc and the sound-box-arm are arranged. The said sound-box-arm is preferably made with a section formed of a composition of celluloid and a fibrous material or of any other suitable material which is a non-conductor of sound, so as to prevent the transmission to the sound horn of undesirable sounds, such as those caused by the movements of the driving mechanism of the instrument.

In the accompanying drawings, it is shown how the said invention may be conveniently and advantageously carried into practice. In this drawing,

Figure 1 is a front elevation and

Figure 2 a transverse section of a talking machine and casing constructed according to the present invention.

Figure 3 is a perspective view of the above apparatus with the cover of the record-disc chamber partially open.

Above the clockwork a is arranged a resonating chamber b. Into this chamber extends the sound horn c having a pivotal tubular arm g bearing the sound-box j. This arm g is capable of turning about a vertical axis on a pivot k and about a horizontal axis at m. The tubular arm g has a section n preferably formed of a composition consisting of celluloid and a fibrous material which has the effect of intercepting grating and other undesirable noises before they pass to the horn c. To the bottom d of the resonating chamber there adjoins a curved surface f which serves simul-

A.D. 1909 JULY 31 N° 17,827.
ZAPPERT'S COMPLETE SPECIFICATION.

(1 SHEET)

Fig. 1.

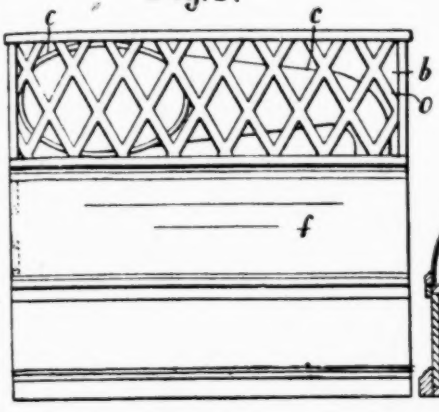


Fig. 2.

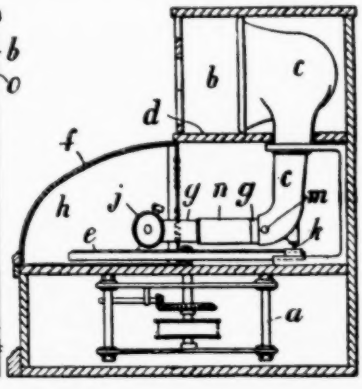
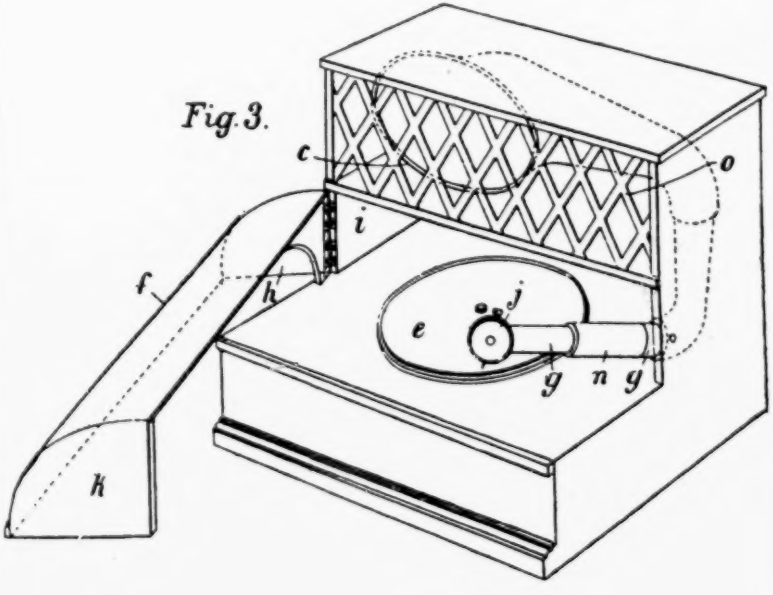


Fig. 3.

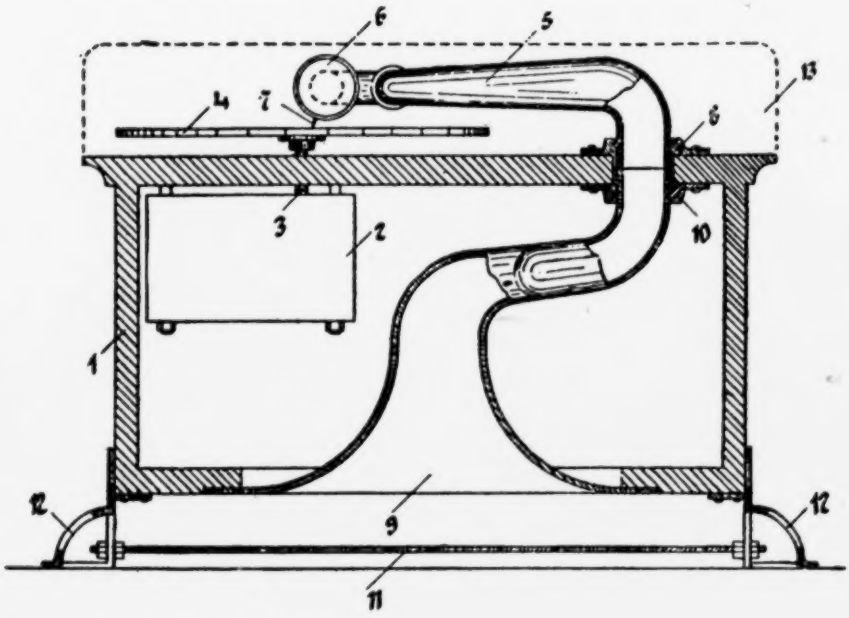


A.D. 1909. Nov 17 N° 26,738.

ROSENTHAL'S COMPLETE SPECIFICATION.

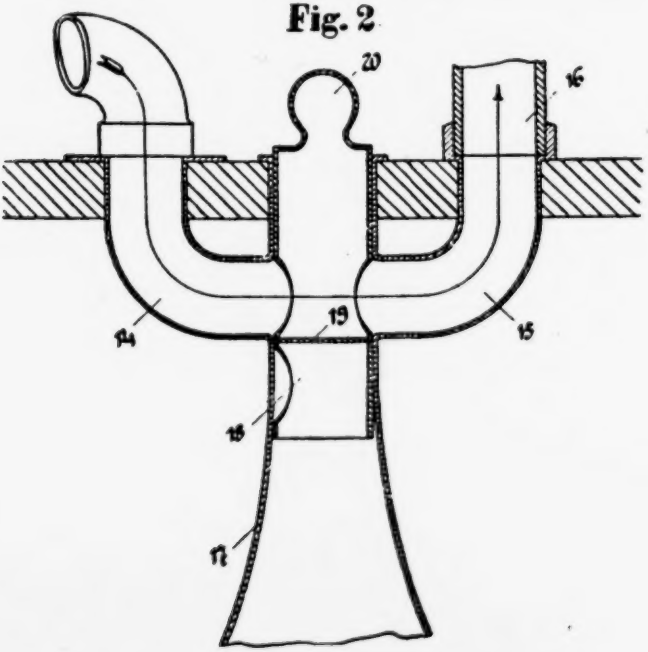
SHEET 1

Fig. 1



[This Drawing is a reproduction of the Original on a reduced scale.]

Fig. 2



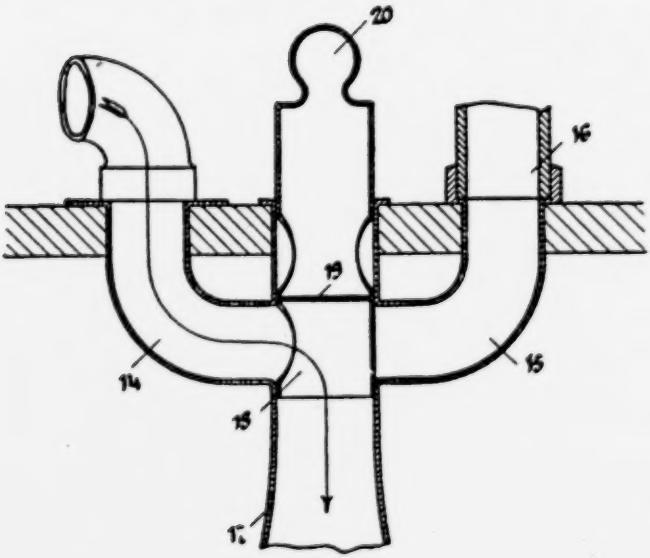


Fig. 3

taneously as a sound-distributor and as a cover for the front part of the chamber containing the record-disc e and the sound-box-arm g.

The curved surface f is provided with two side walls, h, h, of which one is hinged to the wall i of the main casing standing flush with it, so that the curved surface may be swung out horizontally into the position shown in Figure 3.

The front of the resonating chamber b is closed by means [fol. 344] of bars, o, o, or fretwork which may be covered on the inside with a light fabric, such as muslin, silk or the like.

In most of the encased talking machines heretofore constructed, the sound has been conducted downwards on its way out of the apparatus, thereby necessitating the employment of a number of bends in the sound horn or in the tube leading thereto. This arrangement involves considerable loss of volume and purity of the sound, which is entirely obviated by the present construction wherein the sound ascends and passes out directly.

Having now particularly described and ascertained the nature of the said invention and in what manner the same is to be performed, as communicated to me by my foreign correspondents, I declare that what I claim is:

1. A talking machine, characterized in that the horizontal sound horn extends into a resonating chamber arranged above the clockwork and the bottom of the resonating chamber adjoins a curved surface which serves simultaneously as a sound distributor and as a cover for the space in which the record-disc and the sound-box-arm are arranged, substantially as described.

2. A constructional form of the talking machine claimed in Claim 1, in which the sound-box-arm is made with a section of a composition containing celluloid and a fibrous material, for the purpose specified.

Dated this 31st day of July, 1909.

D. Young & Co., 11 & 12, Southampton Buildings, London, W. C., Agents for the Applicant.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1909.

(Here follow drawings, side folios 345 and 346)

[fol. 347] No. 26,738, A. D. 1909

Date of Application, 17th Nov., 1909—Accepted, 14th Apr., 1910

Complete Specification

Improvements in Talking Machines

I, Louis Rosenthal, of 34 Mittelweg, Frankfurt-on-Main, in the German Empire, Merchant, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The present invention relates to talking machines of the class having trumpets mounted within the cabinet or casing. One part of the invention consists in using a downwardly directed internal trumpet having its orifice at or adjacent an aperture in the raised bottom of the casing, so that the sound is uniformly emitted in all horizontal directions. A sound board may be arranged below the aperture. Another part of the invention consists in combining the internal sound-tube with an external sound-tube, and with a switch enabling the two sound-tubes to be alternatively used.

A construction embodying these improvements is shown in the annexed drawing, in which

Figure 1 is a vertical section of the machine.

Figures 2 and 3 show the sound-switch in two different positions.

Referring to Figure 1, the motor is arranged in a box 2 within the casing 1. The record disc 4 is fixed to the spindle 3, arranged somewhat to one side of the casing. The sound-arm 5, which is preferably articulated, carries the sound-box 6 with needle 7, and traverses a bearing 8, in which it joins the horn 9. The latter has its mouth at an aperture in the bottom of the casing. Preferably the bent sound-tube, comprising the arm and the stem of the horn, is made of uniformly increasing cross-section; this improves the sound. A sound-board 11 may be fixed to the feet 12 of the casing, below the trumpet, but is not essential. The casing has a cover 13.

The sound issues uniformly in all horizontal directions from the mouth of the horn, without requiring for that purpose deflection by radial resonance chambers, such as have heretofore been proposed, and the uniformity is more com-

A.D. 1910. JUNE 20. No. 15,675.
LYONS' COMPLETE SPECIFICATION
1 SHEET

[This Drawing is a reproduction of the Original on a reduced scale.]

Fig. 1.

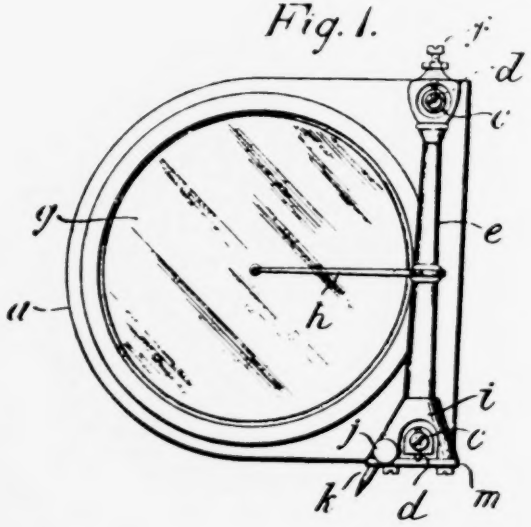
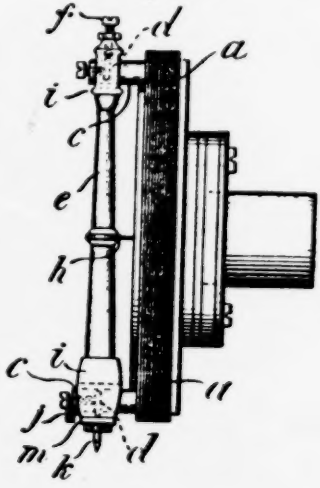


Fig. 2.



plete than can be obtained with deflecting chambers coacting with a horizontally directed horn.

Figures 2 and 3 show a sound-tube comprising two parts 14 and 15. The part 15 is joined at 16 to a horn arranged above the casing. Both the tubular parts 14 and 15 communicate at 17 with the horn in the casing. The part 14 can be placed in communication with either of the horns, the connection being controlled by means of a switch consisting of a tube 18 with a central partition 19, two lateral apertures above said partition, and one lateral aperture below the partition. The tube 18 is open at the bottom and closed at the top, where it has a knob 20 enabling it to be moved up and down. With the tube 18 in the position shown in Figure 2, the sound is emitted by the upper horn; with the tube 18 lowered, as in Figure 3, the sound is emitted by the lower horn. Any other equivalent device may be used for alternatively connecting the tube 14 and sound-box to the tubes 15 and 17.

The provision of alternative horns as described is very valuable in the case of a machine which is to be used both for marches and like music, and for chamber music.

[fol. 348] Having now particularly described and ascertained the nature of my said invention, and in what manner the same is to be performed, I declare that what I claim is:—

1. A talking machine with a downwardly directed sound-tube inside the casing, with its mouth at or adjacent an aperture in the raised floor of the casing.

2. A talking machine as claimed in Claim 1, with a sound-board supported below the aperture in the floor.

3. A talking machine as claimed in Claim 1, with an additional sound-tube leading to a horn outside the casing, and a switch enabling the sound-box to be alternatively placed in communication with the internal and external sound-tubes.

Dated this 17th day of November, 1909.

Herbert Haddan & Co., Agents for Applicant, 31 & 32, Bedford Street, Strand, W. C., London.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1910.

(Here follows drawing, side folio 349)

[fol. 350] resistance should be offered to the free movement of the needle arm and the point of the needle should always maintain a constant position in the sound groove and the object of my present invention is to provide improved means whereby this result may be attained and with this end in view my invention may be said to embody a construction in which the needle bar and the various parts of the sound box are arranged in such a manner that the point of the needle when vibrating will describe an arc of a circle in a plane parallel to the face of the record.

This may be effected by arranging the needle arm as a vertical bar pivoted freely at both ends, from projecting supports at the circumference of the sound box shell, and having an arm projecting at right angles over the centre of the diaphragm with which it is connected by a wire or metal strip or in any other suitable manner said vertical bar carrying upon its lower end means whereby the needle may be mounted.

Under my invention a greater degree of amplification is permitted than in sound boxes heretofore constructed and consequently a fuller and more natural reproduction is obtained.

I have found by actual experiment that the point of a needle after use in my improved sound box takes the exact shape of the sound groove which renders it capable of following exactly every delicate undulation and giving a more exact and perfect rendering of tone.

Dated this 29th day of June, 1910.

Hughes & Young, Registered Patent Agents, 55/56, Chancery Lane, London, W. C.

Complete Specification

Improvements Relating to Sound Boxes for Gramophones and Like Sound Recording and Reproducing Instruments

I, Cornelius Lyons, Accountant, of Gurteenard, Kanturk, Co. Cork, Ireland, do hereby declare the nature of this invention and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement:

This invention has reference to sound boxes for gramophones for reproducing what are technically known as "needle cut" disc records and has for its object to provide improved means for mounting the needle whereby noise and scratching during the operation of the instrument shall be minimized

The invention relates to sound boxes in which the stylus is supported from the sound box shell in such a manner that its point when vibrating describes an arc of a circle in a plane parallel to the face of the record.

The invention has for its object to provide an improved construction of sound box of that type in which a greater degree of amplification is permitted and consequently obtain a fuller and more natural representation.

According to my invention the gramophone sound box is provided with a pair of projecting studs or pillars and a vertical arm pivotted freely from the studs preferably by means of adjustable pivot pins. The vertical arm is connected by a horizontal arm with the centre of diaphragm and secured thereto by a wire or other suitable means. At the lower end of the vertical arm is provided a shoe having a hole bored in which the needle is inserted and clamped in position by means of a thumbscrew.

In order that my invention may be readily understood and [fol. 351] carried into effect by those skilled in the arm to which it appertains I will now proceed to describe the same fully for which purpose reference is to be had to the accompanying drawings in which:

Fig. 1 represents an elevation of a sound box embodying my invention.

Fig 2 is an elevation of the same taken at right angles to the view shown in Fig. 1.

In carrying my invention into practice the shell of the sound box a is provided with lugs or brackets or an extension of the shell itself carrying studs or pillars c in which pivot pins d are mounted. The vertical needle arm e is supported by said pivot pins d as shown a screw f being provided as the top bearing in order that the needle arm e may be so adjusted as to swing freely on the said pins. The vertical arm e is connected by means of the arm h to the diaphragm g to which it is secured by a wire or in any other suitable manner. The lower end of the vertical needle arm e is provided with a shoe i in which the needle k is

mounted in a hole bored for the purpose and held therein by means of a thumb screw j. A plate m screwed to the shoe acts as bearing for the lower pivot pin.

It will thus be seen that with a sound box constructed in accordance with this invention the point of the needle will during operation of the instrument describe an arc of a circle in a plane parallel to the face of the record and consequently a greater degree of amplification is permitted than in sound boxes as heretofore constructed and consequently a fuller and more natural representation is obtained.

I have found by actual experiment that the point of a needle after use in my improved sound box takes the exact shape of the sound groove which renders it capable of following exactly every delicate undulation thus giving a more exact and perfect rendering of tone.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:

1. In a sound box for gramophones and like of the type specified sound recording and reproducing instruments in which the stylus is supported from the sound box shell the combination with a sound box shell of a pair of studs or pillars projecting therefrom, a vertical arm pivotted freely from said studs or pillars and means carried by said vertical arm for supporting the needle point and means for connecting the vertical needle arm with the diaphragm substantially as described and for the purposes specified.

2. A sound box for gramophones and like sound recording and reproducing instruments constructed and arranged and having its several parts adapted to operate substantially as hereinbefore described with reference to the accompanying drawings for the purposes specified.

Dated this 12th day of January, 1911.

Hughes & Young, 55/56, Chancery Lane, London, W. C., and 9, Burgh Quay, Dublin, Registered Patent Agents.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1911.

(Here follows drawing, side folio 352)

A.D. 1910. Dec. 22. N° 29,833.
BROWN'S Complete Specification. (1 Sheet.)

[This Drawing is a full-size reproduction of the Original.]

Fig. 1.

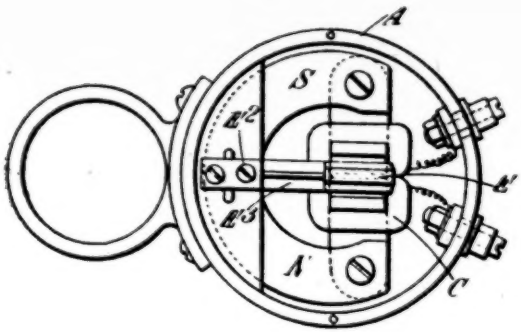


Fig. 2.

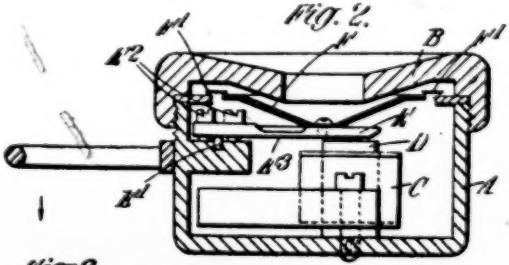


Fig. 3.

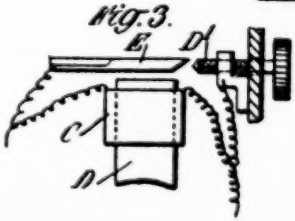
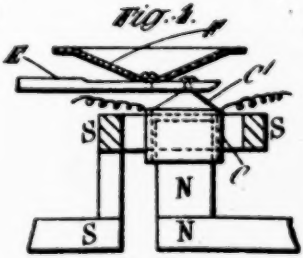


Fig. 4.



[fol. 353] may be quite free, or it may be attached to the inner edge of a flat flexible ring, the outer edge of which is fixed to the casing, the said ring and member thus dividing the latter into two compartments. The flexibility of this ring, and the manner of its attachment to the aforesaid member, should not be such as to hamper or suppress the small vibratory movements of any part of the member to any appreciable extent. The said member may be made of any suitable material, and in this connection I may state that I have found aluminium to be satisfactory.

The working of the device described above will be readily understood. The vibratory movements of the portion of the armature to which the aforesaid member is attached are imparted to this member as a whole; this member therefore acts like a reciprocating piston and sets a large surface of air into vibration simultaneously and to the same or approximately the same extent at all points. In the case of the said member being conically shaped, the increased efficiency is probably due partly to the fact that the disturbances set up in the air in contact with the conical surface tend to converge and to arrive simultaneously at the region where the ear of the operator is situated. In any case the distinctness and audibility of messages received are largely increased, and the range of distance over which speech is practicable is also increased.

Dated this 22nd day of December, 1910.

Haseltine, Lake & Co., 7 & 8, Southampton Buildings, London, England, and 60, Wall Street, New York City, U. S. A., Agents for the Applicant.

Complete Specification

Improvements Relating to the Reproduction of Sound by Electrical Means

I, Sidney George Brown, of 4, Great Winchester Street, in the City and County of London, Electrical Engineer, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement: This invention relates to the reproduction of sound by electrical means and has particular reference to telephone receivers.

The usual telephone receiver consists of a polarised electro-magnet through the coil of which the line currents pass, and a flat soft iron diaphragm gripped peripherally and thereby held a short distance away from the electro-magnet. Variations in the strength of the line current cause the diaphragm to vibrate, and, in so doing, to set the surrounding air into vibration.

In order to obviate the unequal extent of vibration of different points on a peripherally gripped diaphragm proposals have been made to support the diaphragm at its centre leaving the periphery free, or to provide for resiliency or flexibility between the diaphragm proper and its peripheral support, thereby obtaining a piston-like action of the diaphragm. It has been suggested to form such diaphragms of metal, ebonite, or other suitable material, and to impart to them a conical or dished appearance. The chief object of the present invention is to provide an instrument of this kind in which a high efficiency of conversion of oscillations or variations of electric current into acoustic vibrations is obtained. Apart from the actual construction and positioning of the parts of such an instrument, the conditions necessary for the transmission of the air vibrations away from the actual surface of the diaphragm are of im- [fol. 354] portance. Hitherto sufficient attention has not been paid to the volume of air set in motion and the vibrations of air pressure for producing the most effective transmission. The dimensions of the ear-drum and of the aural cavity may be taken as invariable factors in such considerations. Now these factors being known, there are certain relations existing between them and the size of the diaphragm, the nature of the air pressure variations, and the volume of air set in motion, for the most effective reproduction of the sounds, and the transmission of them to the ear-drum. For these and other reasons it is quite impracticable to make the diaphragm fulfil also the functions of an ear piece; a separate ear piece is a necessity.

According to the present invention the receiver comprises a light conical or similarly shaped diaphragm, a resilient member responsive to variations of current strength in a coil through which the line currents pass and carrying the diaphragm by its centre so that the latter is free to vibrate as a whole, and a cover or ear piece situated

over the diaphragm at a comparatively short distance from the same. The inner surface of the cover or ear piece of the receiver is preferably formed to correspond approximately with the shape of the diaphragm, so as to reduce the excessively large space that would otherwise intervene between these parts. I have found that a conical disc formed from a very thin sheet of aluminium or aluminium alloy or steel and suitably stiffened by ribs, or corrugations, or otherwise, possesses the requisite properties to a satisfactory degree. The thin disc, if of aluminium or an alloy thereof, may conveniently be spun into the desired conical shape with a flat centre piece. It is advantageous for the strength and thickness to be greatest at the centre and progressively less towards the edge, and by starting the spinning operation at the edge and working towards the centre, this property of the spun disc will be naturally produced owing to the graduated thickness of the disc. To increase this effect several discs of different diameter may be assembled into a pile. The thickness of such discs may be of the order of 2½ thousands of an inch. Some idea as to the lightness of a diaphragm so formed may be gained from the fact that when it is allowed to drop to the ground it does not fall like a heavy mass of metal, but moves gently through the air. The mere conical shape of the diaphragm will ensure a considerable amount of rigidity but this may be increased by providing radial ribs or corrugations on it as above mentioned.

The viratory member that carries the diaphragm may consist of a resilient strip or reed of magnetic metal containing within itself, by reason of a cut-away portion, its own control and that of the diaphragm. The diaphragm is preferably attached at its centre to a point on the metal strip or reed slightly away from the free end of the latter so as to be eccentric with respect to the axis of the coil through which the line currents pass. The diaphragm is so arranged as to be free to move as a whole, that is to say all points on its surface vibrate equally, and to ensure this action the periphery of the diaphragm is either quite free or is attached to the usual casing by a mere thin ring of flexible material.

In order that the invention may be clearly understood and readily carried into effect I will now describe the same

more fully with reference to the accompanying drawings, in which:

Figure 1 is a plan with the cover removed, and

Figure 2 a sectional elevation, of one constructional form of my improved receiver. These drawings represent a full size receiver, and the more important dimensions such as the diameter of the diaphragm, the extent of its eccentricity, and the volume and shape of the air space between the diaphragm and the ear-piece or cover are what I have found by experiment to give good results for hearing with the receiver close to the ear, by reason, no doubt, of the relation these dimensions bear to the diameter of the ear-drum and the volume of the aural cavity. Where it is desired to make the sounds travel out into the room, a receiver of larger size is preferable.

[fol. 355] Figures 3 and 4 are detail sectional elevations of modifications of the receiver.

Referring first to Figures 1 and 2, A is the casing and B the ear-piece or cover of the receiver. E is a metal reed one end of which is held down upon a bridge piece E^1 on the casing E by two adjusting screws E^2. N and S represents the north and south poles, respectively, of a polarised electromagnet to the ends of which are attached L-shaped pieces the vertical members of which, constituting the cores D, have the coil C wound around them; the ends of the said vertical members slope towards one another so as to be directly under the metal reed E. A portion E^3 of the reed E is cut away to increase its flexibility and decrease its weight. I have found that a suitable free period for the reed is from eight hundred to one thousand two hundred. The extent to which the reed E can approach the core D may be regulated by packing some layers of paper between these parts or by arranging a set screw to make contact with the reed, the provision of a set screw being shewn at D^1 Figure 3. This set screw D^1 may be tipped with gold or platinum so as to serve in conjunction with the reed E as a make and break arrangement in a circuit connected in parallel with the coil C. In this way any damage to the permanent magnetism of the core D owing to an extra heavy current passing through the coil C at any time is avoided, since the closing of the shunt circuit by the contact of the reed E with the set screw D^1 diverts the current away from the coil C.

F is a light aluminium diaphragm of conical form. It is attached at its centre to the reed E at a point eccentric with respect to the axis of the core D, the eccentricity being towards the fixed end of the reed. Although I have shown the best position for attaching the diaphragm in the particular receiver illustrated, the best position on any reed can be found by experiment by means of a stethoscope and by exploring the reed with the aid of a movable diaphragm.

The diaphragm F is either of such a size that its periphery is close up against the casing A or other adjacent stationary part, or, if an appreciable gap exists between these parts, the periphery of the diaphragm is flexibly attached to the casing or to a removable internal flange thereon by resorting to the known expedient of a ring of tissue paper, silk, or other suitable material F^1 that will not exert any appreciable mechanical constraint upon the diaphragm; this ring F^1 may be attached to the diaphragm and to the aforesaid flange by adhesive. In either case the space on the two sides of the diaphragm is divided into two separate air regions.

In the modification, shown in Figure 4, the north pole of the polarised electro-magnet is surrounded by a ring-shaped south pole. In the annular space between these poles is situated a circular frame C^1 on which is wound the coil C. The frame C^1 is carried by the metal reed E. Variations in the strength of the current traversing the coil C cause this coil C to move vertically and thereby cause the frame C^1 to vibrate the reed E, and consequently the diaphragm F also. In this construction it is to be noted that the movements of the reed E do not materially affect the magnetic field between the poles of the electro-magnet.

It will be understood that owing to the extreme lightness of the diaphragm and to its freedom from peripheral constraint, it will be highly responsive to movements of the reed E and will vibrate as a whole.

It will also be observed that the function of the reed E is not to set the air in motion but only to carry the diaphragm and control its movement. This reed contains within itself, by reason of its cut away portion E^1, the means of its own control and that of the diaphragm, and, in the arrangement shown in Figures 1 and 2, also serves to complete the magnetic circuit; the diaphragm forms no part of this circuit. The inner face of the cover or ear-piece B conforms ap-

proximately to the shape of the diaphragm, and its distance from the diaphragm is such as to give only the requisite air space between these two parts. The sectional area of the central hole or holes in the ear-piece is suitably proportioned to the aforesaid air space.

[fol. 356] Although the invention has been described and illustrated with reference to a "watch" type of receiver, it is of course equally applicable to the long handle type of receiver. It has been proved by actual experiment that receivers possessing the constructive features hereinbefore described considerably increase the maximum distance over which distinct speech can be conveyed.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:

1. A telephone receiver comprising a light conical or similarly shaped diaphragm, a resilient member responsive to variations of current strength in a coil through which the line currents pass and carrying the diaphragm by its centre, and a cover or ear piece situated over the diaphragm, substantially as and for the purposes specified.

2. A telephone receiver in which the inner surface of the cover or ear piece situated over the conical or similarly shaped diaphragm corresponds approximately with the shape of the diaphragm, substantially as and for the purpose specified.

3. A telephone receiver comprising a casing, a resilient member responsive to variations in the strength of the line current, a light conical or similarly shaped diaphragm carried at its centre by the resilient member, and a ring of thin flexible material connecting the periphery of the diaphragm with the adjacent wall of the casing or other stationary part, substantially as and for the purpose specified.

4. A telephone receiver, in which the diaphragm attached to the resilient member that is responsive to variations in the line current is situated eccentrically with respect to the electro-magnet, the eccentricity being towards the fixed end of the resilient member, substantially as described.

5. In a telephone receiver, a conical diaphragm built up, or radially corrugated or ribbed, or spun from a disc, in such a way as to be strongest at the centre and of diminishing strength towards the periphery, substantially as described.

A.D. 1911. Jan 16. No 1157.
BROWN'S COMPLETE SPECIFICATION.
(1 SHEET)

[This Drawing is a reproduction of the Original on a reduced scale]

Fig. 2.

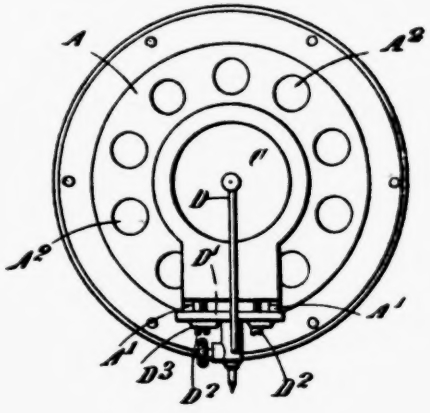
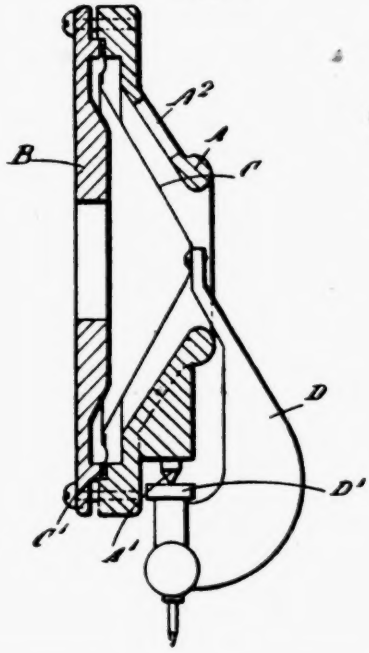


Fig. 1.



6. A telephone receiver, comprising a polarised electro-magnet through the coil of which the line currents pass, a magnetic armature having a cut-away portion to impart resiliency to it, a conical aluminium diaphragm attached to the armature eccentrically with respect to the electro-magnet and towards the fixed end of the armature, and a thin flexible ring of material connecting the periphery of the diaphragm to an internal removable flange on the casing, the latter having a conical inner face conforming approximately to the shape of the diaphragm, substantially as described.

7. A telephone receiver having its parts constructed arranged, and adapted to operate, substantially as hereinbefore described with reference to the accompanying drawings and for the purposes specified.

Dated this 19th day of June, 1911.

Haseltine, Lake & Co., 7 & 8, Southampton Buildings, London, England, and 60, Wall Street, New York City, U. S. A., Agents for the Applicant.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1912.

(Here follows drawing, side folio 357)

[fol. 358] be such that no great changes in the pressure conditions of the air are made to occur suddenly as the air vibrations travel outwards from the actual surface of the diaphragm. In other words an air space that ensures a gradual and uniform change in the pressure conditions of the air should extend not only from the broad outer end of the trumpet to the narrow end of the same or of the tone arm, but should also enable the best air conditions to be maintained between the said narrow end and the actual surface of the diaphragm. The narrow end of the trumpet or of the tone arm may be formed with a single passage leading up to the centre of the diaphragm, or it may comprise several passages the total sectional area of which is not greater than that of the single passage at the point where it branches.

In view of the comparatively large area of the diaphragm above described, the sectional area of the narrow end of the

trumpet or tone arm may be proportionally large, in which case a trumpet with a straight passage would suffice to affect the necessary gradual reduction in the air pressure of the acoustic vibrations before they reach the free air. In the case, however, of a trumpet or tone arm with a narrow end of small sectional area, the passage provided might require to be objectionably long if it were kept straight whilst preserving a gradual and uniformly decreasing sectional area along it, and it may in such cases be advantageous to make the passage tortuous, one portion of it being situated within the other portion or portions.

Dated this 16th day of January, 1911.

Haseltine, Lake & Co., 7 & 8, Southampton Buildings, London, England, and 60, Wall Street, New York City, U. S. A., Agents for the Applicant.

Complete Specification

Improvements Relating to Gramophones and the Like

I, Sidney George Brown, of 4, Great Winchester Street, in the City and County of London, Electrical Engineer, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to gramophones and the like the chief object being to so construct and mount the diaphragm of the usual sound box that it is extremely sensitive or responsive to vibratory influences.

In the ordinary sound box arrangements of gramophones and the like, one end of the stylus bar or lever is attached to the centre of the diaphragm and the latter is gripped peripherally, with the result that since it is not absolutely free to vibrate freely at all points on its surface its responsiveness to vibratory influences is far from being efficient; moreover it is usually comparatively heavy with the result that its inertia makes it sluggish in action.

With a view to removing some of the constraint put upon the diaphragm by reason of its peripheral mounting, it has been proposed to form it with a conical centre portion and a resilient flange portion so that the conical centre portion, the apex of which is secured to the stylus bar or lever, may vibrate as a whole; in such a construction, however, the

damping and constraining action of the flange portion is in my opinion too great to ensure acoustical efficiency. It has also been proposed to transmit the vibrations of the stylus bar to the conical diaphragm through a connecting rod and to mount the diaphragm peripherally by a flexible mounting [fol. 359] of a folding character such as gold-beater's skin so as to ensure a movement of the diaphragm as a whole. I have found by experiment that maximum acoustical efficiency cannot be realized by merely causing the diaphragm to exercise a pumping action upon the air and that in particular a peripheral mounting should be avoided.

The solution of the problem seems to lie in causing the diaphragm to vibrate in such a way that its centre is a node and its periphery an anti-node. The vibrations that the diaphragm should in my opinion perform may be likened to those of a bell the thickness of which is reduced to such an extent that its vibrations are as large as possible in amplitude consistent with being just capable of being damped by the setting up of waves in the adjacent air. Since the centre of the diaphragm requires to be a node the diaphragm should be rigidly mounted by its centre on the stylus bar, and since the periphery requires to be an anti-node it must either be entirely free, or be connected to the casing or other stationary part by material so light and thin that no appreciable peripheral constraint is exercised. The peripheral connection between the diaphragm and the casing or other adjacent part must not be a good absorber of energy, since if it were it would damp the periphery of the diaphragm; on the other hand although it should possess resiliency it must not offer any appreciable mechanical constraint to the periphery. Consequently it must be composed of extremely thin and light resilient material.

According to the present invention, therefore, I realize the above conditions by rigidly mounting a conical or equivalently shaped diaphragm of very light weight by its centre on the usual stylus bar or lever, leaving its periphery either entirely free but very near to the casing or other stationary part, or connected to the latter by a ring of resilient material of extreme thinness—considerably thinner than the diaphragm periphery itself—the formation and the mounting of the diaphragm being in either case such that its centre is in a nodal and its periphery in an anti-

nodal condition. The ring of material, if used, may be connected by adhesive and should have a small amount of sag in order that the diaphragm periphery may vibrate without having any appreciable drag exerted upon it by the ring. Since the diaphragm must be very light though rigid, it may conveniently be formed from aluminium or aluminium alloy, being spun from a thin disc of the same into a conical shape with a flat centre piece. The thickness should be of the order of thousandths of an inch a satisfactory average thickness being 2½ thousandths. It is advantageous for the strength to be greatest at the centre and progressively less towards the edge, and by starting the spinning operation at the edge and working towards the centre, this property of the spun disc will be naturally produced. To increase this effect, several coned discs of different diameter may be assembled together so as to form a pile. In the case of a diaphragm thus built up, the several coned discs may differ in the sharpness of their conical angles.

Owing to the shape and lightness of the diaphragm and to its being rigidly mounted by its flat centre piece it responds very sensitively to sound waves striking upon it and efficiently absorbs the energy of these waves into its substance and concentrates this energy at the centre, and since this is the part at which the support is applied the energy is transmitted with maximum efficiency to the supporting means, that is to say to the stylus bar or lever.

Conversely, in order that the diaphragm may operate to reproduce sound efficiently, it must be extremely light and thin in order that the vibrations imparted to its nodal region may travel through its substance and develop into movements of large amplitude at its anti-nodal periphery; it will be understood that if the amplitude of the vibrations travelling in the substance of the diaphragm is low, and if reflected waves are produced in its substance, as would be the case with a comparatively heavy thick diaphragm, the energy of the vibrations would not be given off to the surrounding air efficiently. It is also essential that the only support for the diaphragm should be that through which the vibrations are imparted to it. Again, it is essential for the [fol. 360] support to be applied at a part from which the energy of vibrations transmitted by means of the support to the diaphragm can spread out uniformly through the substance of the diaphragm. Moreover, the diaphrag*h*m, al-

though light and thin, must be rigid, since otherwise the energy absorbed by the diaphragm becomes wasted in useless unsymmetrical and uncontrollable motions. A diaphragm constructed and mounted as above described complies with these requirements.

If the conical shape does not impart to the diaphragm all the requisite rigidity, it may also be ribbed or corrugated radially in the known manner. Some idea of the lightness of a diaphragm so formed may be gained from the fact that when it is allowed to drop to the ground, it does not fall like a mass of metal, but flutters like a leaf or piece of paper.

In order that the said invention may be clearly understood and readily carried into effect, I will describe the same more fully with reference to the accompanying drawings, in which:—

Figure 1 is a vertical section, and

Figure 2 a rear elevation of a sound box, diaphragm, and stylus lever, constructed in accordance with the invention.

A is the rear part and B the front part of the sound box, C is the diaphragm, and D the stylus lever. The cross piece D^1 carrying the stylus lever D is held against the two knife edges A^1 on the rear part A by two screws D^2 beneath the heads of which are spring washers D^3. The diaphragm C is attached to the stylus lever D at its flat centre piece, and the periphery of the diaphragm is shown connected to the sound box by the ring C^1 of extremely thin resilient material such as glazed tissue paper one three-thousandths of an inch thick or thin collodion film. The width of the annular space must either be so small that the two air regions on the two sides of the diaphragm may be considered as without communication with one another or the ring of material must be used; in the latter case the ring should be slack enough to permit of the diaphragm's movements without any appreciable mechanical constraint being put upon it. This ring instead of being connected directly to an integral part of the sound box, as shown, is preferably connected to a removable metal ring clamped between the rear and front parts. If more constraint upon the bodily movements of the diaphragm is required than is given by the stylus lever, the diaphragm and stylus lever might be secured to a blade spring fastened diametrically across the open central space of the rear part A. However, in most cases such a constraint is not necessary.

The rear part A of the sound box may be formed with several holes A^2 so that the air behind the diaphragm may not be imprisoned to such an extent as to interfere with the vibratory movements of the diaphragm.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim in connection with gramophones and the like is:

1. A very light and conical or equivalently shaped diaphragm rigidly mounted by its centre on the usual stylus bar or lever, leaving its periphery either entirely free but very near to the casing wall or other stationary part, or attached to the latter by a ring of resilient material of extreme thinness—considerably thinner than the diaphragm periphery itself, the formation and the mounting of the diaphragm being in either case such that its centre is in a nodal and its periphery in an anti-nodal condition, substantially as and for the purposes specified.

2. A conical diaphragm so formed or constructed as to be thickest at the centre and of decreasing thickness towards the periphery, substantially as and for the purposes specified.

3. A diaphragm formed by spinning a thin disc of [fol. 361] aluminium or aluminium alloy into a conical shape, the spinning being commenced at the periphery of the disc and continued towards the centre, substantially as and for the purposes specified.

4. A diaphragm built up of several cones of different diameters, substantially as and for the purpose specified.

5. Apparatus having its parts constructed, arranged, and adapted to operate, substantially as hereinbefore described with reference to the accompanying drawings for the purposes specified.

Dated this 17th day of July, 1911.

Haseltine, Lake & Co., 7 & 8, Southampton Buildings, London, England, and 60, Wall Street, New York City, U. S. A., Agents for the Applicant.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1912.

[fol. 362] IN THE UNITED STATES CIRCUIT COURT OF APPEALS FOR THE NINTH CIRCUIT

Appeal No. —

LEKTOPHONE CORPORATION, Appellant,

vs.

THE ROLA COMPANY, Appellee

Stipulation re Foreign Patents

It is hereby stipulated and agreed by and between the parties hereto, pursuant to Rule 15 of this court, that a certified copy of the translation of French Patent No. 127,180 to Ader (1878), being one of the patents comprising Defendant-Appellee's Exhibit No. 9, may be filed with the Clerk of this court and become a part of the printed record on appeal.

It is further stipulated and agreed that the following named prior art patents of Defendant-Appellee's Exhibit No. 9 may be omited from the printed record on appeal:

Canmont et Cie. (French), 331,226—1903.
Welton (French), 362,926—1906.
Persichetti (French), 397,609—1908.
[fol. 363] Muller (German), 183, 685—1906.
Otto (German), 220,412—1909.

Wm. H. H. Davis, Chas. M. Fryer, Attorneys for Plaintiff-Appellant. Chas. E. Townsend, Wm. A. Loftus, Attorneys for Defendant-Appellee.

Dated: March 21, 1929.

[Endorsed]: Stipulation Re Foreign Patents. Filed Apr. 9, 1929. Paul P. O'Brien, Clerk.

(Here follows drawing, side folio 364)

[fol. 365] 390

Department of Commerce, United States Patent Office

To all persons to whom these presents shall come, Greeting:

This is to certify that the annexed is a true copy from the records of this office of a Translation made by the Official

Translator of the Specification in the matter of the French Letters Patent to Ader, Dated October 28, 1878, Number 127,180, for Electrophonic Loud Speaking Receiver.

In testimony whereof I have hereunto set my hand and caused the seal of the Patent Office to be affixed, at the City of Washington, this fifteenth day of March, in the year of our Lord, one thousand nine hundred and twenty-nine and of the Independence of the United States of America the one hundred and fifty-third.

Thomas E. Robertson, Commissioner of Patents.

Attest: D. E. Wilson, Chief of Division. (Seal.)

[fol. 366] Translation of French Patent No. 127,180 of October 28, 1878, to Ader for an Electrophonic Loud-speaking Receiver

In my former patents I have designated by electrophony the new application of electricity to vocal correspondence and I have called the instruments which serve to realize the same Electrophones.

This word, it seems to me, is more suitable than the designations of telephone and microphone.

Electrophony has two parts: transmission and reception.

In the specification which follows I will deal only with the new receiver designed for audition at a distance without it being necessary to apply it to the ear.

This instrument is completely independent of the patents which I have previously taken out; it may have as a transmitter any one of the known systems which it is thought proper to employ.

Before describing the apparatus I believe it will be well to give a summary of my recent researches in electrophonic reception so as to more clearly emphasize the importance of the invention and to characterize it sufficiently.

Hitherto we have not been agreed on the true cause of the reproduction of sound by electrical means; as for me I believe that they are due simply to the differences in the attractions of the armatures by the electromagnets.

Taking this idea as a starting point I have sought for the means of rendering these differences in attraction as great as possible in order to then transform them into vibrations in the air.

[fol. 367] Like everyone I believed that the electromagnets must produce the maximum of vibratory effects when they were large and loaded with wires as is

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the case in the attractions of balls in telegraphy. That is a great mistake as will be seen. If against a diaphragm of very taut parchment on a drum head an armature is fitted and if before this armature there is placed an electromagnet, both of the height customary in telegraphy we have a receiving apparatus; when the transmitter operates this receiver faithfully renders the sounds which are sent thereto but the ear must be put against the diaphragm to perceive them.

If this armature is replaced by another smaller one, keeping the same electromagnet, sounds much more distinct are obtained.

Finally if there is attached to the diaphragm an exceedingly light armature weighing but a few hundredths of a gram and if there is placed before it a selected very small electromagnet the bars of which are only 1 millimeter in diameter sounds will be obtained quite strong enough to be heard at a distance.

In making use of a very thin diaphragm the sounds are still further reinforced and the more this diaphragm is stretched the more the sounds are intensified.

A diaphragm of large surface of about 40 centimeters in diameter gives strong sounds but a little confused; a diaphragm of smaller diameter, about 3, 4 or 5 centimeters [fol. 368] gives very distinct sounds but less strong; the average diaphragms of 10 to 20 centimeters diameter are those which operate the best.

During these operations the same transmitter and the same battery have been employed.

It follows from these experiments that to make receivers capable of giving the greatest effects possible it is necessary to have essentially:

1. Diaphragms as taut as possible and very thin.
2. Very light armatures.
3. Very small electromagnets and in proportion to their armatures.

3

These three conditions are the three principal features of the new receiving apparatus which is the object of the present patent.

The drawing indicates two types of receiver; one, figs. 1 to 3, has but a single electromagnet, the other, figs. 4 and 5 has several of them.

For vocal communication at a distance less than 1 kilometer the receiver with a single eelctromagnet will be sufficient but for great distances a receiver with several small electromagnets must be used so as to have in the wires of all the coils as much resistence as in the conductive wire of the line. This will be very easily obtained with a very thin wire and a certain number of electromagnets.

The number of these small electromagnets for each diaphragm is therefore not limited; it may vary from one to as many as the length of the line may require and the [fol. 369] source of electricity render necessary; they may be placed at will against the diaphragm, either round or otherwise.

The diaphragms will be of thin animal or vegetable parchment, kept very taut by any means on a drum-head frame.

The very light armatures are wedged or hooked against the diaphragm.

The small electromagnets will be arranged opposite their armature so that they can be brought up or removed by the recoil screw.

The question of the smallness of the dimensions of the electromagnets which here plays the principal role requires an explanation; it has its maximum and minimum; as a

4

maximum it may give about 4 or 5 millimeters diameter to the bars and 2 or 3 grams weight to the armature; as a minimum it is possible to construct very small electromag-

smallest sizes

nets; however the [last numbers]* of the fine covered wires limit this reduction in size to about 12 mm. diameter for the bar.

Above this maximum the sound effects diminish considerably; below on the contrary they become accentuated according as the dimensions are reduced.

[*Words and figures enclosed in brackets erased in copy.]

In short, the most favorable dimensions to adopt are those for electromagnets of 1 to 2 mm. in diameter for the bars and for armatures the weight of 1/10 to 1/100 of a gram.

The patent is to protect only the system comprising the thin taut membrane, the light armatures and the small [fol. 370] electromagnets, parts agitating the air; I claim only that.

It is understood of course that the mountings of the frame, the bodies, the stretchers, the supports or suspension of the apparatus, the frame, the sound accessories that may be added thereto as sound boxes or acoustic or harmonic horns etc. and in general the actuation of same as well as the construction method employed are all completely outside the scope of the patent

The attempt might also be made to elude the invention by changing a little the arrangements of armatures or electromagnets indicated in the drawing.

For example it would be possible as in the drawing to prolong the bars of a large electromagnet by making them thin at their extremities and placing them before a light armature or again by not attaching the armatures directly to the diaphragms and by connecting them there by a more or less complicated means: it might also be possible to group several diaphragms which would be equivalent to the combination of several apparatus etc., but all these arrangements and others too although they give appreciable results

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are not as good as that of the drawing in view of its simplicity and furthermore there would always be the use of small bars and small armatures, new means forming part of the patent.

To avoid any dispute I claim each of the new means of the system separately or as a whole.

[fol. 371] Fig. 1 receiver with a single small electromagnet seen in section.

Fig. 2 receiver with single small electromagnet seen from in front.

Fig. 3 receiver with single small electromagnet seen in section.

Fig. 4 receiver with several small electromagnets seen in front.

Fig 5 receiver with several small electromagnets seen in section.

M, thin diaphragm, part claimed.

E, small electromagnet, part claimed.

A, very light armature, part claimed.

B, terminals, part outside the patent.

C, crown support, part outside the patent.

H, frame with locking screw, part outside the patent.

R, case holding the diaphragm, part outside the patent.

S, pedestals or supports, parts outside the patent.

V, recoil screw, part outside the patent.

T, frame, part outside the patent.

Tr/CP.
2/2/26.

[Endorsed:] Filed Apr 9, 1929. Paul P. O'Brien, Clerk.

(Here follow title page and pages 243 and 244 of "Talking Machine News," side folios 372, 373, and 374)

[fol. 375] DEFENDANTS' EXHIBIT No. 12

[Endorsed:] No. 1726. United States District Court. Defts. Exhibit No. 12. Filed 5/10/28. Walter B. Maling, Clerk. By A. C. Aurich, Deputy Clerk

No. 5712. United States Circuit Court of Appeals for the Ninth Circuit. Filed Feb. 5, 1929. Paul P. O'Brien, Clerk.

(Here follows drawing, side folio 376)

[fol. 377] United States Patent Office

John E. Dann and John Lapp, of Honeoye Falls, New York

Telephone-Transmitter

Specification Forming Part of Letters Patent No. 338,660, Dated March 23, 1886. Application Filed December 24, 1885. Serial No. 186,644. (No model)

To all whom it may concern:

Be it known that we, John E. Dann and John Lapp, citizens of the United States, residing at Honeoye Falls, in the

Talking Machine News

VOL. V. No. 60. JULY, 1907. ONE PENNY; POST FREE 2d.

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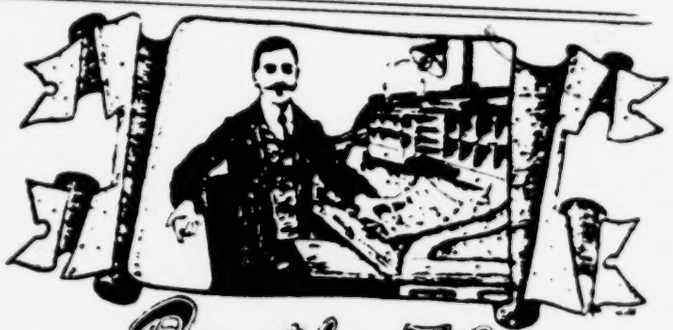


By the Way

SOMEONE has been hoaxing the "Sketch," I should say. That admirably illustrated paper recently contained a paragraph stating that the one and only Edna was annoyed at the statement that she had refused a fee of One Thousand Pounds to make a record of "Follow On" on "General Booth's gramophone." What she winced at, it seems, was not at the report that the offer had been made but at the amount stated. For it was Two Thousand, not One Thousand pounds she had refused! The funny thing about it is that when a member of this staff called at the Salvation Army Headquarters they had never heard of any offer of the kind having been made. In fact, I believe the officer in charge chortled at the idea of it. And I don't wonder, because as you will remember though the "Sketch" didn't Edna took the town in the Belle of New York, with, not to put it too bluntly, a travesty of the Salvation Army lassie. So that the Army would be sure, wouldn't they, to ask her to make a record for them? Yes; I am very much afraid someone has hoaxed the "Sketch" pretty badly.

* * *

THE gazetteer describes Hayes, Mdlx., as a village three-and-a-half miles from Uxbridge and its staple trade as fruit-growing and agriculture. But I looked in vain for Hayes the other day, as I passed in the train the place where it once was. It was as though it had never been. It was obliterated, hidden away by a gigantic legend in black and white which informed

THE "VIBRATOPHONE": A NEW PHONOGRAPH.

By Sydney G. Starling, B.Sc., A.R.C.Sc., F.Phys.S., and W. Cole, F.L.S.

We have devised a new form of phonograph which appears to be of sufficient scientific and general interest to merit a description in the pages of the TALKING MACHINE NEWS. The attachment was originally intended for use with a Pathé "Perfecta," and it is so simple that it may be made in half-an-hour at a cost of material that can only be reckoned in farthings.

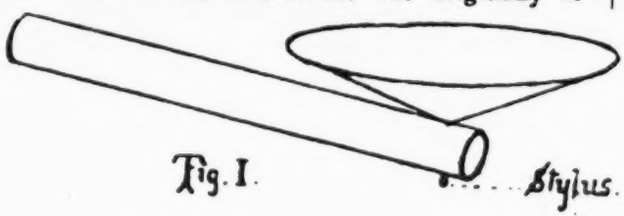


Fig. 1.

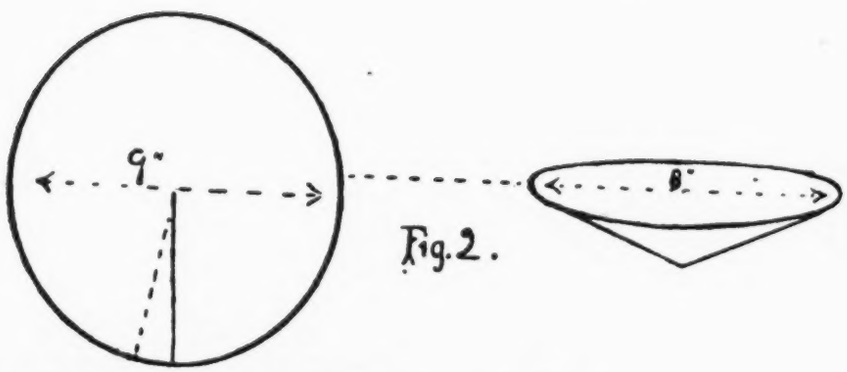


Fig. 2.

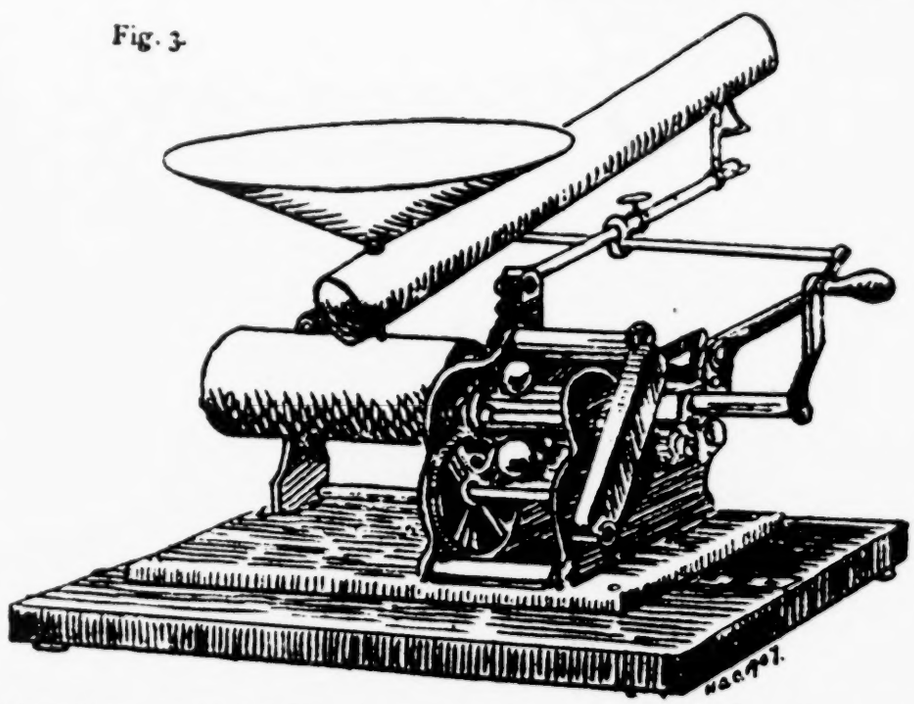
It consists of a low cone of cartridge drawing-paper 8 inches in diameter, and about 2½ inches high. This may easily be obtained by making a circle of the paper and cutting out a segment, as shown in Fig. 1, then bending the cone into shape, and securing with wax or cement. This paper cone is attached at the apex with wax or seccotine to a tube of millboard or cardboard, such as those sold by stationers for posting drawings and maps. This tube may be about 2 inches in diameter, and for fitting to the "Perfecta" it should be at least 12 or 13 inches long. The tube is open at both ends, and at the end immediately under the point of the paper cone, but, of course, on the opposite side of the tube, is fixed with wax or other cement a ball-stylus or sapphire. Our styli are made from thin rods of glass drawn out and fused in a spirit lamp, so as to form a thin thread of glass with a little spherical end, care being taken to get the ball of the right size, and with perfectly polished surface. A real sapphire stylus would doubtless be best.

Near the other end of the cardboard tube a hole is drilled to allow of the insertion and screwing fast of the little jointed rod by which the horn of the "Perfecta" phonograph is balanced on the guide-rod of the Orpheus attachment. The construction and mode of fixing up our device will easily be followed by an inspection of figures 2 and 3.

Some little judgment must be exercised in fitting up the apparatus to allow the tube to travel on the record from end to end without touching the wires of the Orpheus attachment.

Our object in the first place was to produce a diaphragm which should be large and rigid enough to set sufficient air in vibration to produce audibility without the intervention of a trumpet; our paper cone must be looked upon as a modified diaphragm and not in any sense a trumpet. It was intended in this way to avoid the distortion of the sound waves which

Fig. 3.



must occur in the cavity of the reproducer and horn, which cavity has such a complex shape that it is almost impossible that all the overtones of any note or sound should be reproduced with their intensities in the same proportion as in the original sound. In fact the cone in our arrangement behaves to the record and the style as the sounding board behaves towards a vibrating string. If the board is rigid and encloses no complex air space its vibration is a good copy of the vibration of the string; it merely serves to set more air in motion than the string alone could do. Thus our cone must have only sufficient curvature to give it rigidity. A perfectly rigid weightless plane would be an ideal form for the cone to take. The cardboard cylinder forms a convenient and efficient support for the cone, but whether it plays any acoustical part in the reproduction is an open question.

The sound, though much less intense than that produced by the ordinary method, is yet very pleasing and correct. The result is particularly good with low volume "home records," and to our ears the characteristics and timbre of the reproduction are pure and natural.

Although our experiments have been made with the "Perfecta" it would be easy to adapt the "Vibratophone" to other styles of machines. We appear to have selected roughly good sizes of cone and tube, still there is doubtless room for experiment in the selection of diameter and length. Celluloid and cardboard have been tried for making the cone, but in our experience paper is by far the best material.

The "Vibratophone" (to christen the little device) appears to have some practical uses beyond its scientific interest. It would serve excellently to try over records without disturbing others in the house when they need to be repeatedly played as in the study of folk-songs and language lessons by aid of the phonograph.

FORTHCOMING REDUCTION IN PRICE OF THE EDISON RECORD.

An official announcement, which has been sent out by the National Phonograph Co., Ltd., to dealers selling their records, will be found in another part of this imprint. On and after August the 6th they are to be sold to the public at a shilling, instead of eighteenpence, as heretofore. It affords us much pleasure to be able to congratulate this Company on their latest move, which we think is a statesmanlike one. The reduction has been generally anticipated by the trade for a long time past as inevitable, but it is not everyone who has the good sense to know when to bow before the inevitable. There are, of course, an abundance of sound reasons for reducing the price by one-third. Competition, as between the record manufacturers, grows more and more acute day by day. And there can be no doubt that this Company must have been handicapped for some time past by the fact that many millions of excellent records were to be bought and were being sold at a shilling, whilst the price of this record remained at eighteenpence. We regret that the Company should not have supplied us with a copy of the notice. It should be obvious that such a reduction was bound to come to our knowledge and was a fit subject for treatment in these columns. It was doubtless an oversight on their part that we should have been compelled to procure a copy of the document from another source. Because the futility of trying to keep the matter a secret so far as we are concerned is obvious to the meanest intelligence. That foolish bird the ostrich is wont, as has often been remarked, to hide its head in the sand upon the approach of the sportsman, under the persuasion that it will not then be seen.

The reputation which the National Phonograph Company have acquired for business acuteness makes it quite plain that they cannot have intentionally adopted this policy towards the "Talking Machine News." Especially as the notice, as our readers will appreciate, has a special interest for ourselves, since as long ago as February, 1906, we stated in these columns that a rumour was current at that time that a reduction in the price of "Edison" records was likely to take place. We may therefore claim, in spite of the fact that the statement was made the subject of an action for libel against us by this company, which for reasons best known to themselves was subsequently settled by them paying the entire costs, that we did in fact anticipate in advance what has now taken place. A letter will be found in this issue from a dealer drawing attention to what he considers the defects in the conditions of the notice. He points out that the allowance is only made on condition of further purchases being made during the slackest time of the year. This certainly seems a weak point, and we should be inclined to think that a more generous treatment would have been more profitable in the long run. Orders, so runs the clause, must be placed with the factors during the next five months ending with October 31st, 1907. And with so sweeping a reduction of price it does seem hardly the thing to speak of the allowance as a "gratuitous one." It is doubtless true that no legal obligation lay with the Company to make any allowance at all, but there are other obligations besides these, which are necessary if one would preserve a good understanding with one's clients. We would suggest that there is still time to issue a fresh notice modifying the first, for there can be no doubt that in some respects it has not produced an agreeable impression upon the trade as a whole. We note the announcement that the price of Edison machines remains the same.

PASTIMES, LTD., is a place where one can comfortably while away a leisure hour. Situated about a stone's-throw from Charing Cross, it is easy of access to pleasure lovers, theatre lovers, and lovers of every category. One of the most attractive features is an automatic contrivance whereby the eye and ear are mutually delighted by a phono-mutoscope, whilst downstairs there is an athletic room affording exercise and relaxation to those disposed that way.

Mme. Roger Miclos, whom Rubinstein praised, has made a number of piano records for the Fonotipia Company. The special list of them which has been issued comprises five double-sided discs.

(No Model.)

J. E. DANN & J. LAPP.

TELEPHONE TRANSMITTER.

No. 338,660. Patented Mar. 23, 1886.

Fig. 1.

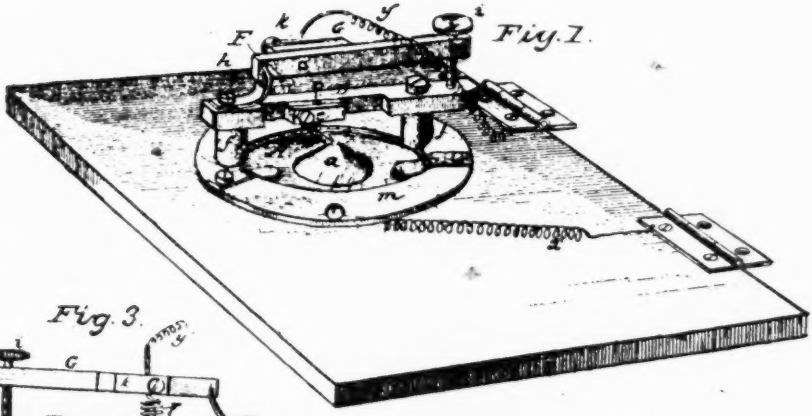


Fig. 3.

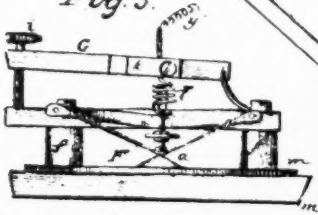


Fig. 2.

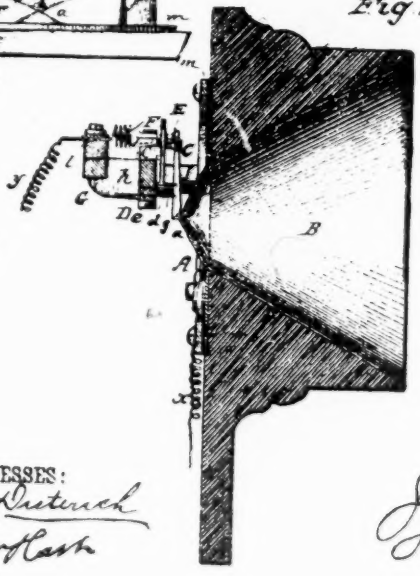


Fig. 4

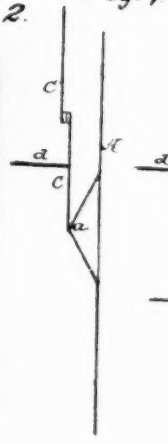


Fig. 5.

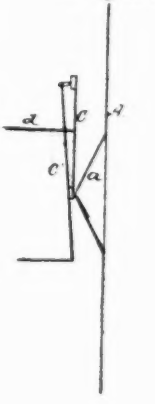


Fig. 6

WITNESSES:

Fred. G. Dieterich

Amos W. Cass

INVENTOR:

John E. Dann

John Lapp

BY Munn & Co

ATTORNEYS.

county of Monroe and State of New York, have invented a new and useful Improvement in Telephone-Transmitters, of which the following is a full, clear and exact description.

Our invention is an improvement in the class of transmitters having vibrating electrodes arranged adjacent to and one of them normally pressing upon the diaphragm, and in some cases attached to it.

The object we aim at and have attained is the production of a loud-speaking instrument capable of operating with a minimum expenditure of battery-power or electro-motive force.

To this end we have devised a new and simple construction of the diaphragm, and and also provided a new and improved mechanism for co-operating therewith, as hereinafter fully described.

In the accompanying drawings, Figure 1 is a perspective view of our invention applied to the door of a transmitter-box. Fig. 2 is a central cross-section of the same. Fig. 3 is a side view of a portion of the mechanism, Figs. 4 and 5 illustrate modifications. Fig. 6 illustrates a defective operation of the ordinary diaphragm employed in telephones.

The sheet-metal diaphragm A is constructed with a central conical portion, a, which may be formed integral therewith or made separately and attached by solder, brazing, or in any other suitable manner. The diameter of the base of the hollow cone may be varied considerably; but we prefer it shall equal and even slightly exceed that of the contiguous inner end of the mouth-piece B, of which it forms practically a conical extension. By this construction and combination of parts the whole force of the air-current or sound-waves from the mouth of the person speaking into the instrument is concentrated on the cone—that is to say, on the central portion of the diaphragm—thereby producing the maximum effect in respect to the required vibration of the latter, and the transmission of sound with corresponding loudness, force, and precision.

A lever, C, which constitutes one of the electrodes, is permanently attached to the apex of the cone a through the intermediary of a spring or other device which will allow the lever to vibrate within certain narrow limits. The lever may, however, be rigidly attached to the cone, and in that case of course the diaphragm must yield enough to permit

due vibration of the lever. The fulcrum of the latter is a spring or flexible plate, d, which is held adjustably by a clamp, e, to a fixed bar, D, supported by posts f. A shorter lever, C, is arranged parallel to and in front of the former, C, and also attached to its middle portion by short spring, g, which constitutes a yielding fulcrum that permits slight movement of such shorter lever toward and from the other. The outer or free end of this lever C″ has an eye or socket that holds the other electrode—to wit, a short metallic pin, E. The latter is suitably insulated in the socket by rubber or equivalent means. The inner end of the pin E rests normally in light contact with the free end of lever C, and it is the vibration of these two parts C and E, corresponding exactly to the vibration of the diaphragm, that effects the transmission of speech.

It is obvious that the contact points or electrodes proper may be multiple instead of single, although we prefer and intend to use the latter.

When a current is sent through a freely-suspended carbon electrode, it is repelled somewhat from an opposite electrode. We utilize this principle of replusion as an aid in avoiding the "stick," which two metallic electrodes exhibit, by inserting a piece of carbon in the outer or free end of the lever C, so that the metallic electrodes rests in contact therewith, instead of with the lever proper. By this means rapidity of vibration of the electrodes is efficiently promoted, and the instrument thereby adapted to transmit speech with greater fidelity and speed.

As a means of support and adjustment for the pin-electrode C, we connect it by means of a spiral spring, F, with a lever, G, which is arranged parallel with the fixed bar D, and attached to it by a flexible fulcrum-piece, h. Said lever is provided with a screw, i, at its opposite or free end, for adjusting it closer to or farther from the bar D. A screw-clamp, k, secures the spring E to the lever, and it is suitably insulated by a rubber block l.

[fol. 378] In practice the diaphragm A and spring F are connected by wires x y with the primary of an induction-coil and with a battery, neither of which is shown in the drawings; or the instrument may be set in a battery-circuit with an intensity-coil properly connected with the line-wire. When a sound-wave strikes upon the diaphragm, its main

force is concentrated at the center, which is capable of the greatest amplitude of vibration, and the consequent movement of the diaphgram is transmitted to the electrode-lever C, so that the free end of the latter vibrates with a greater amplitude than the diaphragm, owing to the fulcrum d being nearer the end attached to the cone a. This vibration of the lever-electrode C effects the transmission of sound through the receiving instrument at the other end of the line.

In addition to the function of the cone a in concentrating the sound-waves, as above stated, it has a still more important one, which we will explain as follows: When a sound-wave strikes upon a diaphragm of the usual form with whose center an electrode rests in contact, the latter resists more or less the tendency of such central portion to yield and assume a concavo-convex form, and consequently the portion surrounding the center yields first, as illustrated in an exaggerated way in Fig. 6, in which A' indicates the diaphragm and C'''' an electrode. The result is a failure to transmit and reproduce sound with the desired loudness and accuracy; but by use of the cone a this defect is avoided, since the air-wave pressure forces back the cone or central portion of the diaphragm before or else simultaneously with the portion that surrounds it. In other words, the diaphragm vibrates with the freedom and in the manner required to produce, in connection with the other mechanism employed the desired perfection of result.

A still further advantage attends the use of the cone, since it is capable of withstanding the pressure and thrust to which it is subject in acting on the attached lever, and hence the diaphragm is made correspondingly more durable than if constructed in the usual form.

In further relation to the cone a we desire it to be understood that while it is desirable and even necessary that its inner side shall be open, as shown, in order to produce the best result, yet we do not propose to here limit ourselves to such construction, since a good degree of success may be attained by closing the base of the cone—that is to say, by employing a diaphragm of the ordinary form and attaching a hollow cone to its center.

Our improved diaphragm is applicable to other telephonic instruments beside transmitters.

In respect to adjustments it may be stated that the spring-fulcrum d of the inner lever-electrode, C, is properly adjusted when the apparatus is prepared or "set up" for use. The lever G is adjusted by screw i to increase or lessen the tension of the spring F, and thereby regulate the contact-pressure between the electrodes E C, as required for the desired perfection of operation.

In practical operation of the instrument a metallic sound arises from the molecular or mechanical vibration of the movable parts, particularly the electrode-levers and the spring F. To quickly destroy such vibration we employ elastic bands, Fig. 3, which are stretched between suitable points of attachment and press lightly on the spring and pin-electrode E and both levers C and C', as shown. It is also expedient to employ dampers or elastic pressure-plates, as shown in the drawings, to limit the vibration of the diaphragm, and thus choke out the metallic clang.

We do not propose to limit our invention to the described and preferred arrangement of levers shown, since various others are practicable. As an example, the outer electrode might be attached to the lower end of a metal strip of bar, C, as shown in Fig. 4, and said bar may be a spring, or it may be inelastic, and in the latter case the action of gravity would be depended on to hold it in light contact with the other electrode, C'.

Fig. 5 illustrates still another arrangement, wherein both levers C C' are attached to the cone, which thus acts directly on both when vibrated.

We are aware that a diaphragm having a conical portion with a surrounding annular part which is curved transversely (or in cross-section) has been suggested or employed, and we therefore restrict our claim to the precise construction of our diaphragm, which experiment has demonstrated to be advantageous.

We propose to file another application in which the function and advantages of a carbon electrode in transmitters of this particular class shall be fully described, and in which it shall be claimed more broadly than in this application.

What we claim is:

1. The diaphragm having a central hollow cone and a surrounding annular part, all portions of which are flat or

DEFENDANT'S EXHIBIT No. 19.

W. H. DAVIS AND F. E. JOSS.

ACOUSTIC DIAPHRAGM.

APPLICATION FILED MAY 13, 1918.

1,389,632. Patented Sept. 6, 1921.

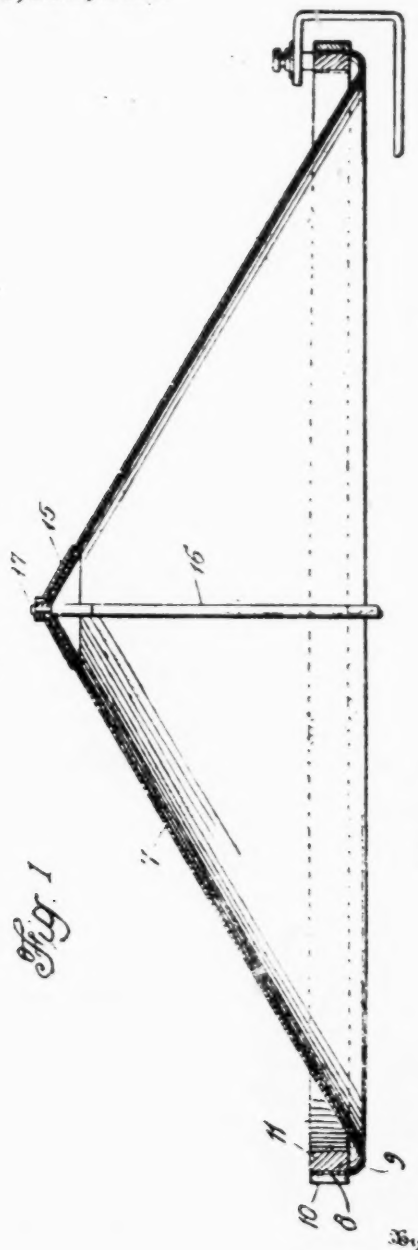


Fig. 1

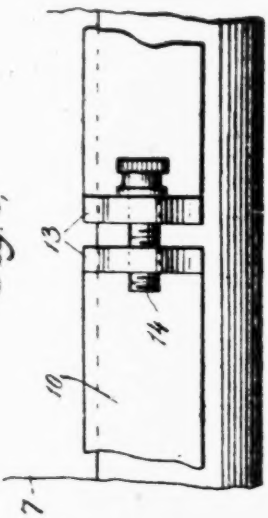


Fig. 3

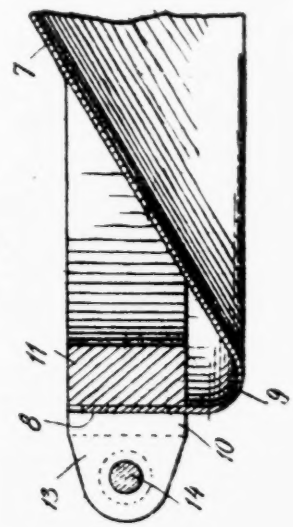


Fig. 2

Inventors
William H. DAVIS
Fredrick E. JOSS

By their Attorneys
Pennie, Davis, Marvin & Edmonds

lie normally in the same plane, said diaphragm being free to vibrate, as shown and described.

2. The combination, with the diaphragm and its central hollow cone, of electrode-*d*evers having yielding fulcra, and one of them attached to said cone, substantially as shown and described, to operate as specified.

3. The combination of the spring F with the connected electrode-levers, the spring or elastic fulcra therefor, the diaphragm having a hollow cone to which one of said levers is attached by a yielding connection, all as shown and described.

4. The combination of the spring F with the pin-electrode, the lever C, and the cone-diaphragm, substantially as shown and described.

5. In a telephone of the character hereinbefore specified, [fol. 379] the combination, with the diaphragm and an electrode, E, of the lever C, connected with the diaphragm and carrying a carbon contact-point.

6. The combination, with the diaphragm and the lever-electrode C, attached thereto, and the spring-fulcrum d therefor, of the electrode C′ and its spring-fulcrum g, substantially as shown and described.

7. The combination, with the diaphragm and the vibrating lever-electrode C, attached thereto and having a spring-fulcrum, of the second electrode-lever, C, and a spring-fulcrum therefor, which connects it with the other, C, at a point between the fulcrum and free end of the latter, as shown and described.

8. The combination, with the diaphragm, the electrode-levers, the spring F, and a fixed bar, D, of the adjusting-lever G and the screw i, all arranged as shown and described to operate as specified.

John E. Dann, John Lapp.

Witnesses: Amos W. Hart, P. B. Turpin.

(Here follows drawing, side folio 380)

[fol. 381] United States Patent Office

William H. Davis, of Bronxville, and Frederick E. Joss, of Brooklyn, New York, Assignors to Lektophone Corporation, a Corporation of Delaware

Acoustic Diaphragm

Specification of Letters Patent

1,389,632 Patented Sept. 6, 1921

Application Filed May 13, 1918. Serial No. 234,104

To all whom it may concern:

Be it known that we, William H. Davis and Frederick E. Joss, both citizens of the United States, residing at, respectively, Bronxville, county of Westchester, State of New York, and borough of Brooklyn, county of Kings, city and State of New York, have invented certain new and useful Improvements in Acoustic Diaphragms; and we do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to acoustic diaphragms, and in particular to diaphragms of the type which, while capable of use in other and different apparatus and for different purposes, are designed primarily for installation in talking machines of the general character disclosed in the patent to Marcus C. Hopkins No. 1,271,527.

According to the disclosure in said application, the diaphragm is of such a nature as to effect the direct propagation, in free air, from a record or equivalent element subjected to the action of the original sound waves or vibrations, of self-sustaining sound waves substantially corresponding in intensity and amplitude, as well as in pitch and timbre to the said original sound waves, as distinguished from an initial generation of violent air disturbances in a small, confined space, and a subsequent transformation of such disturbances into self-sustaining sound waves by means of a megaphone, horn or like amplifier. The diaphragm is of relatively great area and of conical form, terminating at its base in a supporting rim or flange, and is rigidly

mounted at its said rim; the shocks or vibrations being transmitted, by suitable means or devices, to the diaphragm in the direction of its apex, so that the entire conical portion is caused to move bodily.

The object of the present invention is to improve a diaphragm of this character, by so constructing it as to reduce to a very large degree, if not entirely, the possible distortion of the vibrations transmitted to or imparted by, the diaphragm, due, in part, to the direct and rather rigid connection of the base of the cone to the supporting rim or flange, (which has the effect of somewhat damping the vibrations), and, in part, to the cone base itself, which may, perhaps, exert a similar action, but in less degree, by reason of such connection. This object is effected by avoiding the direct connection just referred to, and, instead, joining the base of the cone to the supporting rim or flange by a curved, open-topped trough, which provides a resilient mounting for the cone and is constructed and arranged in such a way as to destroy distortive action due to the presence of the rim and at the same time to resiliently support the cone itself. The supporting rim for the outer edge of the conical diaphragm comprises a pair of concentric nesting rings, which are arranged to grip the outer edge of the conical diaphragm and support it, so that the said outer edge is substantially vertical. The degree of resiliency that is given to the open topped trough may be regulated by clamping more or less of the outer edge of the conical diaphragm between the nested rings.

Referring now to the drawings which illustrate one embodiment of the invention, Figure 1 is a sectional view taken through the axis of the cone; Fig. 2 is a fragmentary sectional view showing a detail of the supporting rim and associated parts of the cone; and Fig. 3 is a front view of a detail.

Referring more particularly to said drawing, 7 indicates, generally, the conical portion of the diaphragm, and 8 its supporting rim or flange, these two parts being separated or spaced from each other by the intermediate, open-topped annular trough 9, hereafter more fully described. The rim 8 of the cone is clamped between a pair of concentric nested rings 10 and 11, so that it is substantially parallel to the axis of the cone and is substantially vertical as seen in the

drawings. The outer ring 10 is provided with a pair of terminal flanges 13 provided with cooperating threaded apertures in which an adjusting bolt 14 engages. It will be apparent that through manipulation of this bolt 14 the clamping action of the two rings may be regulated and the area of the rim 8 that is gripped between the two rings readily adjusted. The cone 7 has secured to its apex a cap 15, preferably consisting of two conical members located upon opposite sides of the cone and having a threaded connection which enables them to be tightened together so as to [fol. 382] grip the material of the cone between them. Any suitable connecting device may be employed for transmitting from the record or its equivalent to the diaphragm, or vice versa, the sound waves to be reproduced, or recorded, such connection being here shown, as embodying a rod 16, one end of which is fastened to the afore-mentioned cap by a screw 17.

The cone, trough and rim are preferably constructed from a single piece of material, which should be crisp, strong and suitably rigid or stiff, yet light and vibratile, and with as little inertia as possible, hot compressed paper or other fibrous material of like character having been found to answer the purpose satisfactorily. The cap 15′ is made of extremely light and very rigid metal.

As is apparent from Fig. 2, the wall of the trough 9 is made appreciably thinner than the wall of the cone itself and the rim 8. The thinning of the lower portion of the cone wall may be so carried out that said wall is gradually and inappreciably increased in thickness as it rises from the trough until a point is reached which is at some considerable height above said trough.

This thinning of the trough (and of the cone wall if adopted) is effected after the diaphragm has been formed, and constitutes an important feature of the invention, since because of it the resilience of the trough with relation to the rim is increased beyond the normal, so that the cone is rendered responsive to virtually the maximum degree to the vibrations imparted to it and is enabled to move sharply and bodily at each vibration, while returning, or tending to return, to its normal position immediately at the conclusion of its movement in one direction. this being due to the crisp, resilient nature of the material of which the diaphragm is made. The "normal" resilience above referred to is in-

tended to indicate the degree of resilience which the trough would possess if its thickness were constant throughout and were the same as the thickness of the rim and the cone. Consequently, the distortion to which the sound waves would otherwise be subjected, is avoided, owing to the removal of the damping action exerted by the rim upon the vibrations, as has already been explained. The resiliency imparted to the vibrating cone is regulatd by clamping more or less of the rim 8 of the cone between the nested rings 10 and 11. Thus, when the rim is inserted to its full, or nearly its full, extent between the rings, the trough is brought closer to the bottom of said rings and is, in consequence, held more rigidly than is the case when only a comparatively small portion of the rim lies between the rings. In the latter case, the extent of the exposed portion of the rim is such as to allow the trough relatively great freedom of movement, and the resiliency of the mount is proportionately increased.

We claim:

1. An acoustic diaphragm, comprising a central, vibratile cone, an annular supporting rim encircling said cone at the base thereof, and an annular trough between said cone and said rim and providing a resilient mounting for the former; and a support for said diaphragm comprising a pair of nested rings between which said rim may be inserted to different extents to vary the resiliency of said trough with relation to said rim.

2. An acoustic diaphragm, comprising a central, vibratile cone, an upstanding supporting rim encircling said cone at the base thereof, and an annular trough connecting the lower portion of said rim and said cone base and providing a resilient mounting for the cone; and a support for said diaphragm comprising a pair of nested rings between which said rim is rigidly held.

3. An acoustic diaphragm, comprising a central, vibratile cone, an annular supporting rim encircling said cone at the base thereof, and an annular trough between said cone and said rim and providing a resilient mounting for the former; a support for said diaphragm comprising a pair of nested rings between which said rim is inserted; and means providing for a relative adjustment between said rim and said rings, to vary the degree of resilience of the mounting.

William H. Davis, Frederick E. Joss.

[Endorsed:] No. 1726. United States District Court. Lektophone vs. Rola. Defts. Exhibit No. 19. Filed 5/10/28. Walter B. Maling, Clerk. By A. C. Aurich, Deputy Clerk

No. 5712. United States Circuit Court of Appeals for the Ninth Circuit. Filed Feb. 5, 1929. Paul P. O'Brien, Clerk.

(Here follows drawing, side folio 383)

[fols. 384 & 385] DEFENDANT'S EXHIBIT No. 34

[Endorsed:] No. 1726. United States District Court. Defts. Exhibit No 34. Filed 5/11/28. Walter B. Maling, Clerk. By A. C. Aurich, Deputy Clerk.

No. 5712. United States Circuit Court of Appeals for the Ninth Circuit. Filed Feb. 5, 1929. Paul P. O'Brien, Clerk.

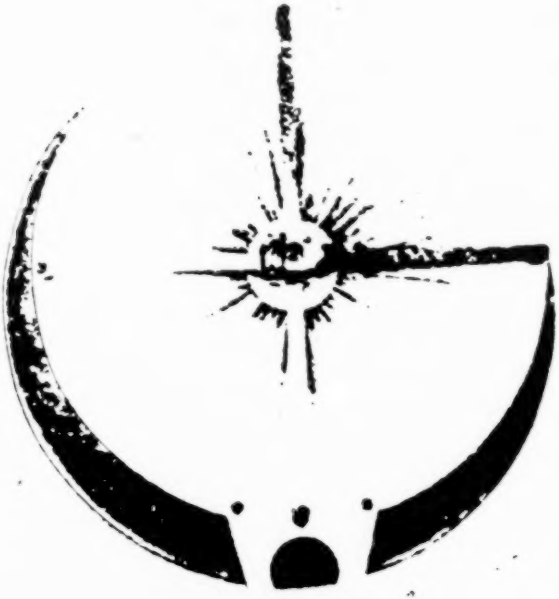
[fol. 386] SUPREME COURT OF THE UNITED STATES

ORDER ALLOWING CERTIORARI—Filed January 27, 1930

The petition herein for a writ of certiorari to the United States Circuit Court of Appeals for the Ninth Circuit is granted. And it is further ordered that the duly certified copy of the transcript of the proceedings below which accompanied the petition shall be treated as in response to such writ.

Endorsed on cover: File No. 34,651. U. S. Circuit Court of Appeals, Ninth Circuit. Term No. 520. Lektophone Corporation, petitioner, vs. The Rola Company. Petition for writ of certiorari and exhibit thereto. Filed December 16, 1929. File No. 34,651

DEFENDANTS EXHIBIT D 4



United States Patent Office

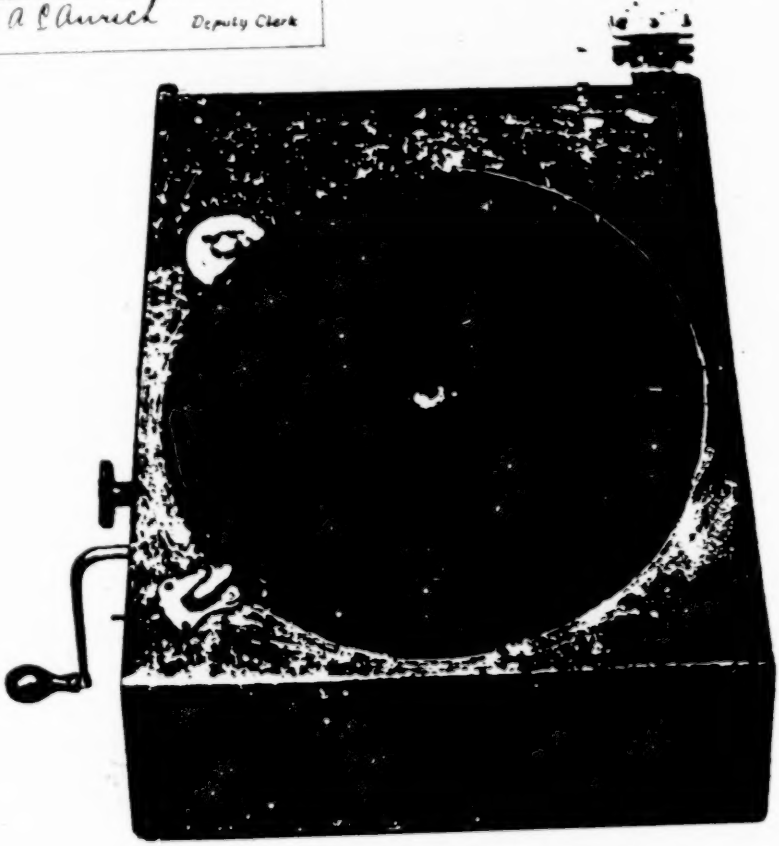
No. 1726

Serial No. Current No. 34

Filed 5/11/29

WALTER B. MALING Clerk

By A. L. Amrich Deputy Clerk



NO.
UNITED STATES CI
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FEB 5
PAUL P.